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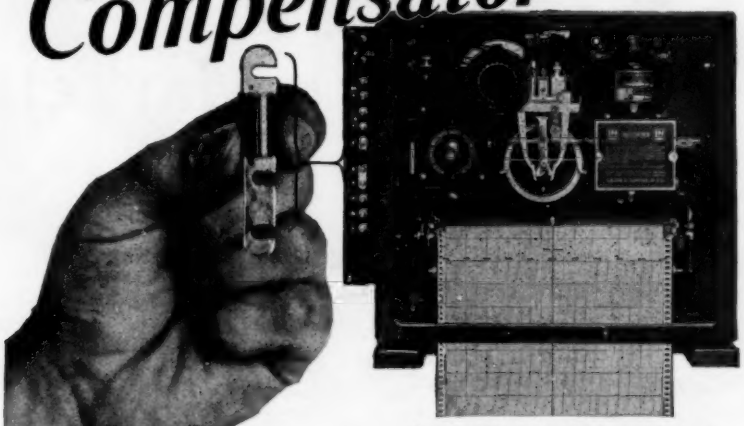

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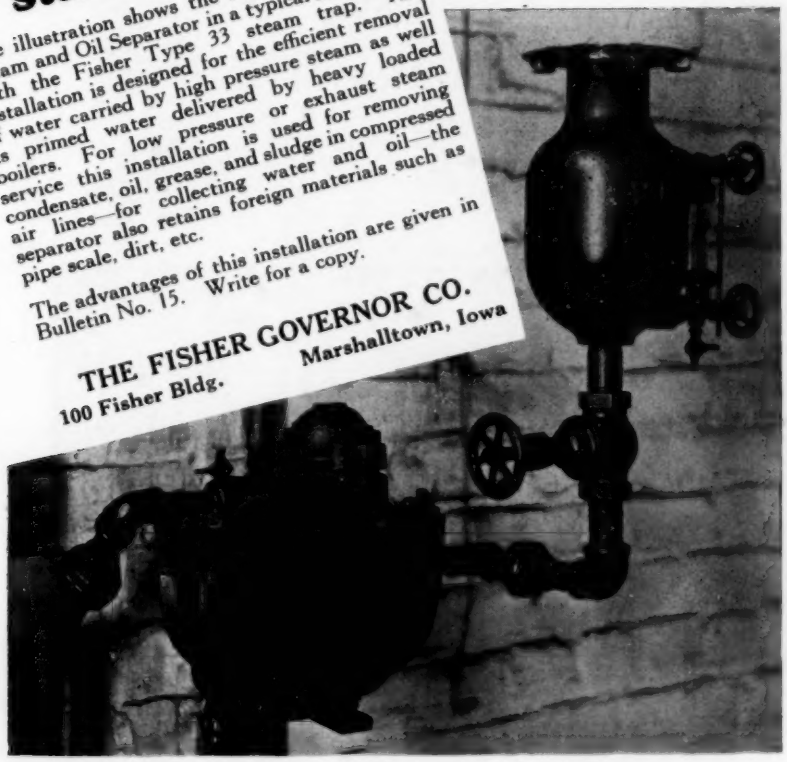

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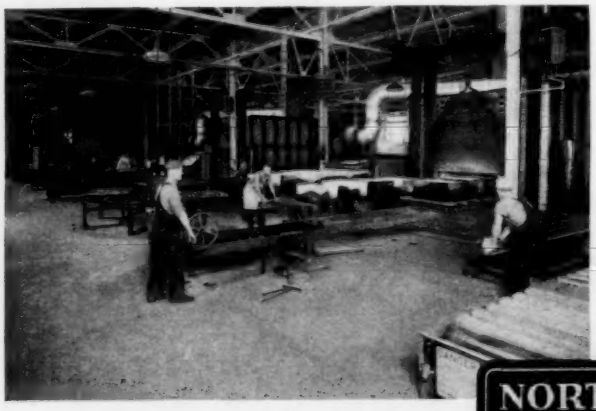

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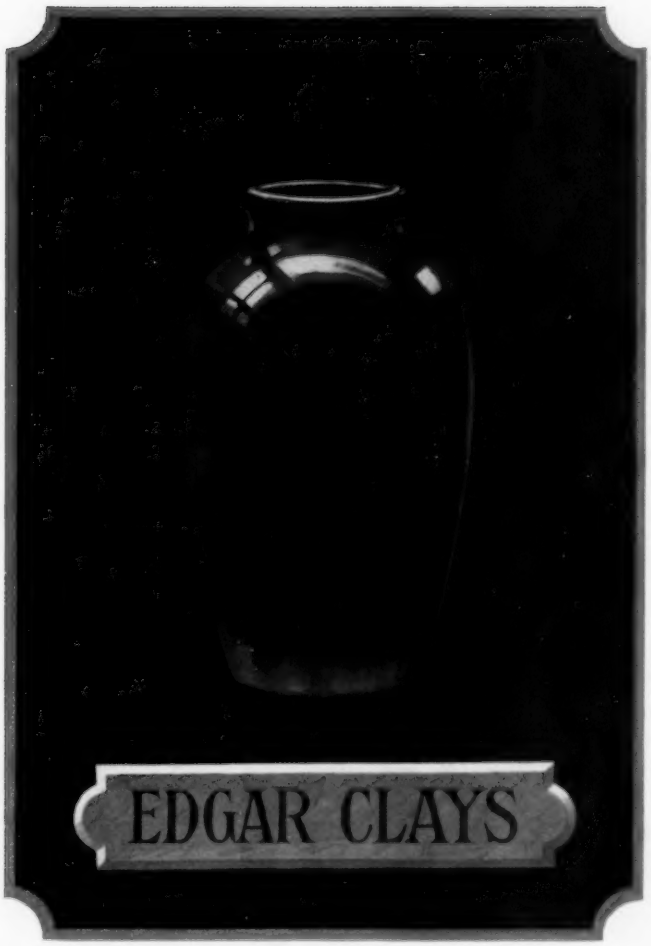
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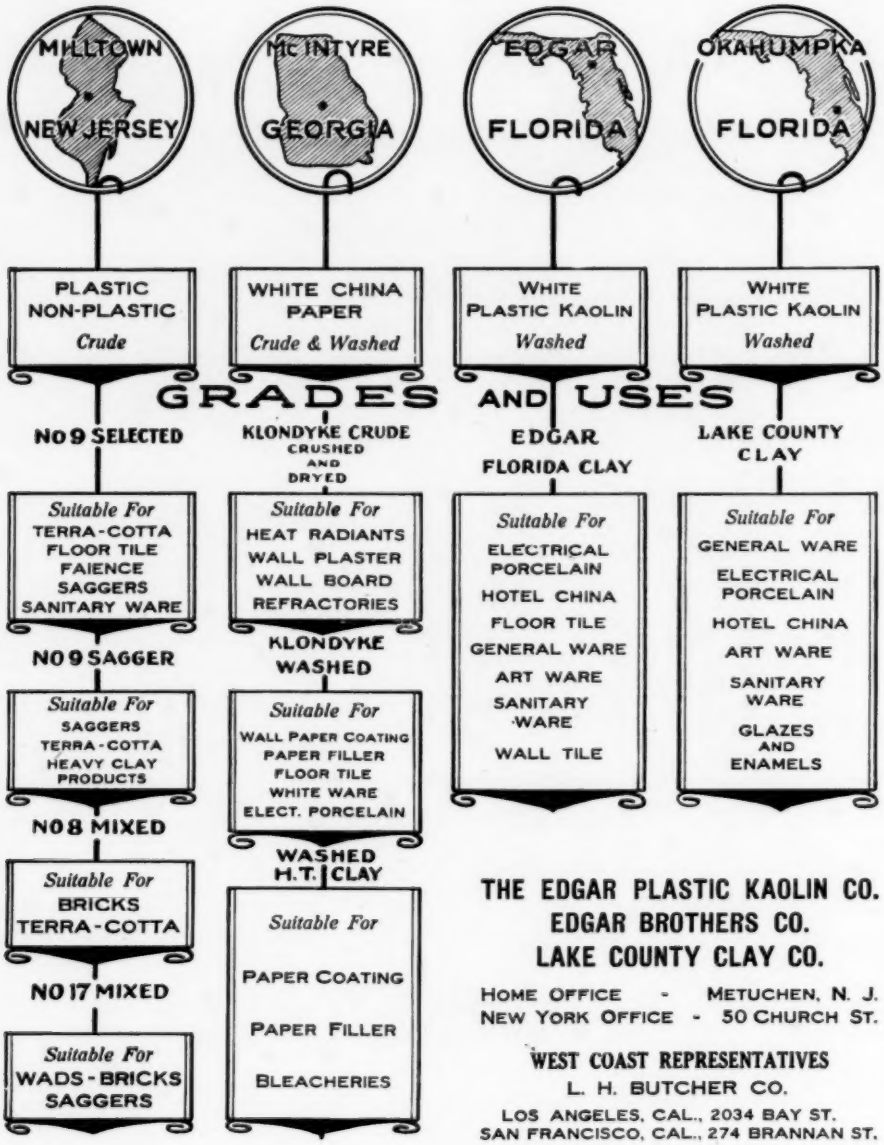

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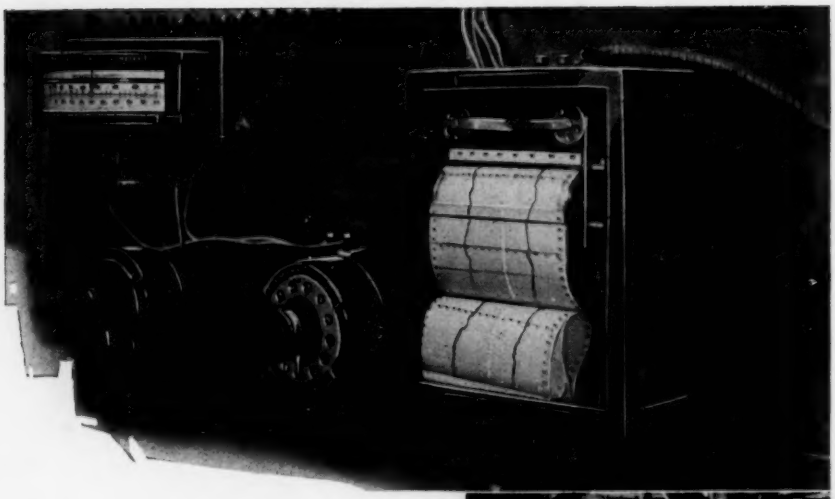

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Table of Contents

JULY, 1929

The Journal

A Coke-Fired Gas Producer for the Ceramic Industry—Barrett 435
The Use of a Small Cupola in Testing Cupola Refractories—MacKenzie 443
A New Type High Temperature Fusion Furnace—Shaw and Bair 447
The Relation of a Modulus of Grain Size to the Mechanical Strength of Sagger Mixtures—Birch 451
Optical Methods as an Aid to the Study of Refractories—McVay 455
Progress Report on Investigation of Sagger Clays. V—Heindl and Mong 457
Present Practice in Whiteware Periodic Kiln Design—Mills 481
Cause and Control of Color Variation in Cast-Iron and Sheet-Iron Enamels—Wenning 491
A Deformation Study of Cobalt Oxide-Iron Oxide-Silica Mixtures—Shepherd 494
The Incrustation of Ceramic Ware—Lenchner 498
Linoleum Block Printed Pottery—Loshinsky 502

Ceramic Abstracts

465

The Bulletin

Editorials

Masonry Engineering 181
Some Commencement Day Thoughts 182

Activities of the Society

New Members Received from May 1 to June 1 183

Notes and News

Permanent Committee on Simplification of Variety and Standards of Vitrified Paving Brick 184
Paving Brick Institute Organized at Roseville 185
New Jersey Clayworkers' Association 185
Ceramic School Notes:
Open House Show of the Department of Ceramic Engineering, Iowa State College 185

Calendar of Conventions 186

Membership Roster of American Ceramic Society 187

Membership Roster of American Refractories Institute 238

Advertisers' Index 3

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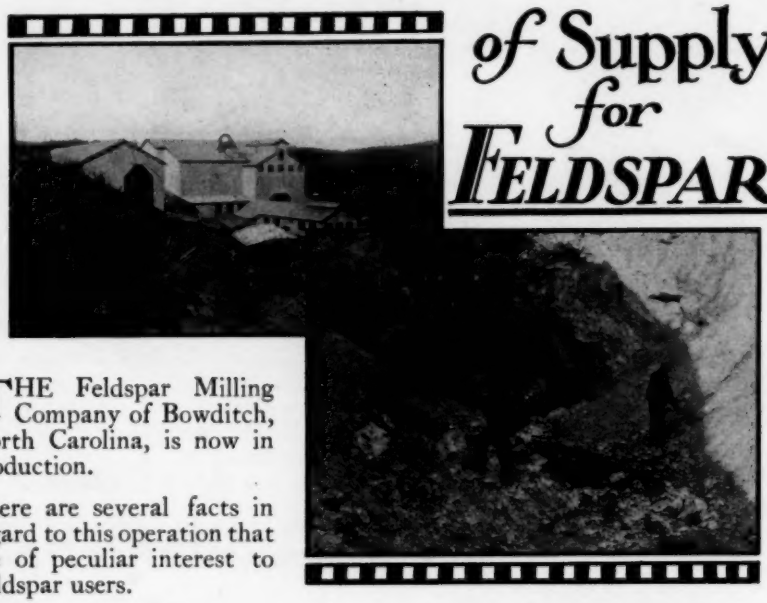

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A COKE-FIRED GAS PRODUCER FOR THE CERAMIC INDUSTRY[1]

By H. C. Barrett

ABSTRACT

The initial installation of a coke-fired gas producer for manufacturing gas for firing silica brick in the United States is described in detail. The advantages of cold, clean gas over dirty gas are pointed out with clarity. The features of the automatic operation are set forth, showing that a better grade of constant volume and pressure gas can be produced. Operating data of a plant on million cubic-foot basis gives the power, coke, and water consumption.

Introduction

The summer of 1928 marked the advent of the coke-fired gas producer into the refractories industry in the United States. Two producers of the Koppers Kerpely type were installed in a Middle West silica brick plant for heating a new continuous kiln. These machines are of the same type which are employed in large numbers by the by-product coke-oven and gas-oven industry for underfiring their installations. The general use of coke-fired producers is not new but their application to the ceramic industry is a development worthy of consideration of all connected with this industry.

The use of hot producer gas manufactured from coal is well known in the glass plants and in some of the other branches of this industry. The difficulties in maintaining gas of even quality and at a steady pressure accompany the operation of a coal-fired producer. The gas contains dust and tarry materials that cannot be removed economically. These substances cause plugging of the mains, requiring frequent swabbing and shutdowns. They also may produce kiln marking since the dust is a mixture of ungasified coal and ash. The tar produced is of little value and must be classed as a loss in the efficiency of the gasification process.

Advantage of Coke-Fired Producer

The gas from a coke-fired producer is free from the many disadvantages of the coal-fired producer. The fuel being of graded size, the fuel bed may be maintained so that the gas produced is of even heating quality and delivered at a constant rate. It is not necessary to poke the fire in order to break up the coke. Since the fuel employed contains less than 2% volatile matter normally there is little or no tar formed and the dust may be practically removed by scrubbing with water. The gas delivered by the coke-fired producer plant is of even temperature, of constant heating value, of low sulphur content and essentially dust- and tar-free, with ease in operation.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.) Received Jan. 10, 1929.

Producer gas gives a long, uniform burning flame which can be readily controlled to produce a heat distribution impossible to obtain with coal fired directly, or with richer gases, which burn with a short intense flame. The long flame will aid materially in procuring an even firing in kilns. The use of gas in any case of heat application permits a higher degree of temperature control and regulation than can be approached by directing firing with solid or liquid fuels. The combustion can be regulated and so set that it will always be complete and smokeless within the limits of the heating system. The necessity of fuel transportation about a plant is eradicated when gas is the fuel used for firing. The labor for stoking kilns is lowered when gas is employed for heating.

When firing with cold clean producer gas it is, of course, necessary to employ some type of preheating in order to obtain readily the temperatures encountered in ceramic processes.

The use of a regenerative system for preheating the gas and air may be readily applied to a heating furnace of a tunnel kiln or glass tank, and a recuperative system can be installed in conjunction with the stack flue of a periodic kiln or enameling furnace. By preheating the gas and air it is possible to attain high temperatures and the efficiency of the kiln is materially raised. The recovery of the stack-gas losses by preheating the air, when a solid or liquid fuel is used, would produce too high a temperature at the point of combustion, thus causing failure of bag walls, fire boxes and side walls, and possibly developing too great kiln losses due to localized heating.

It is not the intention of the author to discuss the subject of coke-fired producer operation, as this has been dealt with quite thoroughly by F. Denig in a paper[2] entitled "Coke-Fired Producer-Gas Operation" in which extensive operating data on twenty-one producers is available.

Description of the Koppers Kerpely Producer

A gas producer is a hollow, cylindrical shell with a grate and ash pan at the bottom and a fuel charging device and gas offtake at the top. The sides of the Koppers Kerpely producer (Fig. 1) are formed by a steel water jacket which extends vertically from the grate to the crown. This design prevents any clinker formation on the shell of the machine as would be the case if the sides were brick lined. The steam generated in this jacket is collected in the low pressure steam drum located above the producer on the charging floor. A portion of this steam supplies the total requirements for gasification and a surplus is available for feed water heating for the high pressure boilers, or the heating of buildings or other uses where low pressure steam may be employed.

[2] Carbonization Committee Report, 1927, American Gas Association.

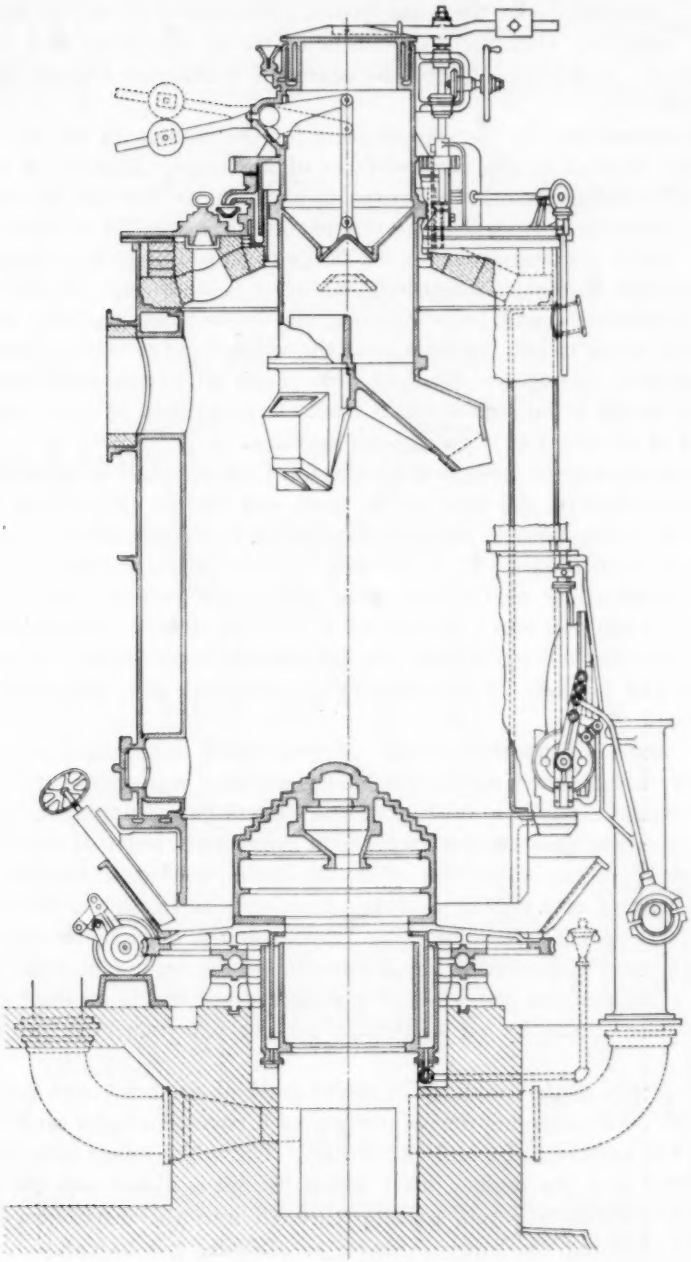

FIG. 1.—Kerpely gas producers.

Air is supplied under the grate from a turbo-blower at several inches of water pressure. Uniform distribution of air to the perforated cone is insured by introducing it into the center of a chamber located beneath the grate.

The perforations in the conical grate for the passage of air and steam blast are located in the vertical faces of the steps. Instead of coming through radially, these holes emerge at an angle so that the axis of each passage faces away from the direction of rotation instead of at right angles to it. There is no tendency for ash particles to roll or to be crushed into the openings, no matter whether the air blast is on or off. As there are a large number of small holes covering the entire grate surface, the distribution of air is very uniform over the whole base of the producer and consequently throughout the fuel bed. Such an evenly distributed air blast is bound to be superior to a blast admitted only at fixed points or limited radial zones as is the general practice.

Heavy castings or pushers of special form are attached at diametrically opposite points on the base of the grate and against the bottom of the ash pan. These serve to prevent the slipping of the ash by friction against the water-sealed extension of the shell and to carry this material around to the discharging plow. This plow directs the ash up and over the side of the ash pan into a chute leading to a bin or other disposal system. Being powerful and continuous, the ash disposal is not subject to the limitations and troubles of the intermittent disposal and stationary grate system.

The grate is supported by the ash pan which is mounted on a roller race-way and is slowly revolved while the machine is in operation. Apron plates extend down from the jacket into the ash pan, dipping into a water seal in the pan, thus making an air-tight connection, but still allowing the grate and ash pan to revolve while the jacket remains stationary. The grate is placed in a slightly eccentric position with respect to the vertical axis of the jacket; thus, in being turned, a sort of churning motion is brought about which forces the ash down under the apron plates and thence to the outside of the pan where it is ploughed out and is dropped into an ash disposal chute by an adjustable scraper which is attached to the jacket.

The crown of the producer is constructed of fire brick and insulating material. The charging device consists of a covered hopper with a drop bell at the bottom and a fuel distributor. The bell is raised when the fuel is charged into the hopper, after which the lid is closed and the bell is lowered, allowing the fuel to drop through into the distributor chutes without shutting the machine down or allowing gas to escape. Three distributor chutes extend downward and outward to the top level of the fuel bed. The fuel is kept in these legs or chutes and the hopper and

distributor are constructed to rotate slowly and continuously, spreading the fuel evenly and keeping the level of the fuel bed at a constant height.

Blasting with air alone would give a very hot combustion zone, causing the ash to fuse into a hard clinker. By the addition of steam to the air

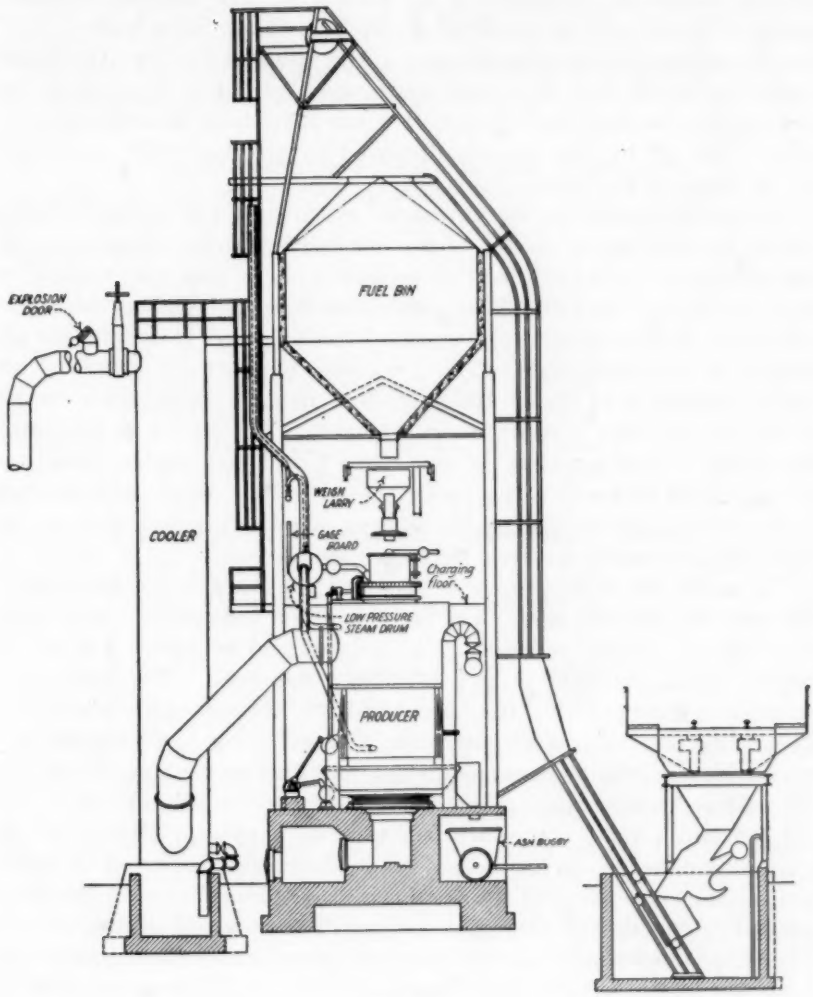

FIG. 2.

the combustion zone is cooled to a temperature just below the fusing point of the ash. This steam at the same time enters into a chemical reaction with the hot coke forming hydrogen and carbon monoxide. The steam is obtained from the jackets as was previously mentioned. The

amount used is controlled by keeping the temperature of the air and steam mixture at a constant point. This is done by an automatic regulator, and very close control can be obtained. The ash in various cokes will be found to require different proportions of air and steam and hence different saturation temperatures are necessary. The amount of steam usually required will amount to about $^1/_2$ lb. of steam per pound of coke. This is equivalent to air saturated with steam at about 135°F. The result is that the ash is kept in a loose, unclinkered condition, which does not obstruct the air blast and offers no trouble in its removal from the machine. The air for the blast is furnished by an electrically or steam-driven blower of the centrifugal type.

The gas produced is led away from the machine by a brick-lined offtake pipe in the shell above the top of the fuel bed. The gas temperature at this point is about 1100°F and to recover some of this heat the gas is frequently conducted through a waste-heat boiler of the vertical tube type where high pressure steam is produced to furnish power to operate the air blowers or other equipment. The installation of a waste-heat boiler cannot be justified in all plants, this depending upon the value which can be allowed for the high pressure steam produced. The gas leaves the waste heat boiler at a temperature of about 500°F and then passes through a hurdle-packed cooler. In this cooler the gas is thoroughly washed with water which cools the gas to atmospheric temperature and removes all dust and tarry material carried over from the producer.

The producers themselves will be found to require very little labor and none of a manual type. The fuel charging is done with no other work than that of opening and closing the hoppers and bells since the fuel is stored in a bin overhead which is filled by a skip hoist. This hoist automatically removes the fuel from a railroad track hopper and transports it up into the bin. A weighing larry car is generally used between the fuel storage bins and the producer so that a check may be made of the current rate of fuel consumption. The ash is handled so that it falls out of the ash pan into a dump cart which facilitates its removal. Thus it will be found that one man can handle two gas producers taking care of the oiling and greasing, charging, and the measuring of the fires at three- or four-hour intervals. All other operations are taken care of automatically and require only the operator's attendance to check the performance of the equipment.

An installation of this type described above is the result of years of experience and application to several industries, principally, however, to coke-oven plants of coke-fired producers. The installation is a complete working unit in itself, each detail of which represents the best of engineering knowledge. Automatic controls, regulators and recording devices for temperature, pressure, saturation and volume measurements insure efficient and economical operation, free from the operating difficulties and

nonuniformity of gas production. The somewhat higher initial investment required for an installation of this type compared to that of coal-fired gas producers is offset by the numerous advantages and efficiencies when considered over a number of years of operation.

Operating Data

The following is typical operating data for the producers described, all figures being based upon a million cubic feet of gas produced:

Coke	6.95 tons
Power for operating air blower, grate and top drive, water booster pump and fuel skip hoist motors, as well as lights	135 kw.-hr.
Water to scrub and cool the gas	25,000 gal.
Water evaporated in producer jacket	1600 gal.

A Typical Gas Analysis

CO	27.0
CO_2	4.5
O_2	0.2
H_2	12.3
N_2	56.0
B.t.u. per cu. ft.	125 to 130 net

Proximate Analysis of Coke (Moisture-Free Basis)

Volatile matter	1.22
Fixed carbon	88.69
Ash	10.09
Sulphur	0.66
Fusion point of ash	2372°F
B.t u. per lb.	12,876

In Koppers Kerpely producers, small sized coke such as breeze, pea, nut, or intermediate sizes, can be used without any difficulties in operation.

A producer, 8 feet 6 inches, has a gasification capacity of approximately 5,000,000 cu. ft. per day.

Conclusions

In conclusion it is desired to point out the chief advantages which are possessed by coke-fired gas producers and the use of producer gas in the ceramic industry. These can be summed up as follows:

(1) The design of the modern coke-fired gas producers is such that a clean, uniform gas is assured continuously with a very high over-all efficiency of gasification and operation.

(2) Practically all control and regulation is automatic and all material handling is done by labor-saving devices which result in a minimum of operating labor. The labor required is not of a highly skilled type.

(3) Heating with gas gives a control of heat application that is more efficient, flexible, and uniform than any method of direct-fired solid fuel combustion.

(4) Producer gas can be most efficiently used in a regenerative or recuperative system which is simple to operate and assures a minimum loss of heat in the waste gas leaving the system.

(5) Operation and maintenance costs are low when all factors entering into the matter are considered.

KOPPERS COMPANY
PITTSBURGH, PENNSYLVANIA

THE USE OF A SMALL CUPOLA IN TESTING CUPOLA REFRACTORIES[1]

By James T. MacKenzie

ABSTRACT

A small cupola is lined on one side with the refractory under test and on the other side with one whose service record is known. A highly oxidizing melt is run, followed by thorough scouring with fluxes. The difference in resistance between the two materials gives a fairly accurate test on the usefulness of the one under test. Three typical tests are given in detail with the corresponding corroborative service records.

Introduction

The complexity of conditions in a cupola melting zone is so great that it is very difficult to test foundry refractories in any apparatus except the cupola itself. For some time the writer has been making tests on refractories in a small cupola. It is a No. 0 Whiting having a 27-inch shell and lined with $4^1/_2$-inch lining to give 18 inches inside diameter. It has two tuyères 17 inches above the mantle plate and 70 inches below the charging door.

The Cupola

One side of the cupola is lined with the test brick and the other side with brick of known service record. The lining is straight from mantle plate to top plate, these being the reference points in the lining and measurements. The line between the two bricks is preferably right over the tuyères, as in that arrangement anything happening to one tuyère will not destroy the test.

This cupola requires 30 No. 2 arch brick and 4 No. 3 arch brick for each circle. Use of the correct arch brick insures a minimum of grout. Only 2 or 3 rows of brick are necessary to test a particular product as action 20 inches above the tuyères is not worth considering. Therefore, this requires only 45 No. 2 arch brick and 6 No. 3 brick to test a given refractory.

In the case of plastic refractories it is personal preference whether or not brick are used up to the tuyères. A wooden form is put in and rammed to whatever height is desired and the form can then be removed or burnt out. This insures rapid drying, which does away with the bothersome dry cracks which occur with slow air drying. The overall height being only a little over 8 feet it is very easy to ram the material from the bottom on up. In this case split brick may be inserted to prevent the two plastic refractories from coming in contact, or they may be allowed to come together without any serious trouble.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.) Received January 15, 1929.

Conduct of Test

The procedure in running a heat on a new lining is to first put in a bed from 30 to 36 inches above the tuyères with fairly good foundry coke. When this is thoroughly burnt through, charge about 200 pounds of a decent grade of gray iron, either pig or scrap, the idea being to get some clean metal through the tap hole and see that the bottom is thoroughly warm so there will be no danger of a subsequent freeze-up. After that the procedure may be varied to suit the individual conditions.

In general it will be found preferable to run with a low coke ratio, preferably of the order of 6% and to use finely divided dirty scrap. Our own preference is the use of mixed steel turnings and cast-iron boring as these oxidize rapidly and the ferrous oxide is easily the most corrosive material in the cupola.

It is better to run the greater part of the heat without slag. Slag, by diluting the iron oxide, will very often decrease the action on the lining.

After the main part of the test is over, it is well to run considerable quantity of limestone through the cupola. This cleans off the walls and gives it a bath of basic slag, another condition which the refractory would have to face in practice. A run of two to three hours under these conditions is usually enough to destroy at least half the lining in some spots and this is sufficient for most purposes.

Measuring Slag Action

After the heat, the bottom is dropped and the cupola allowed to cool and then chipped down thoroughly so that nothing protrudes from the wall, especially in the bottom to keep the straight edge from touching the mantle plate. A long, straight edge is then let down in the cupola and with a rule the distance from the straight edge to the wall is measured in as great a number of points as may be desirable. Our practice is to read at every 60°, starting at 30° from the joint. This gives three planes vertically, and as we read at every 3 inches beginning at or just above the tuyères, depending on the height at which scouring begins, we get from 15 to 18 readings from each refractory under test. These are then averaged and the average noted as well as the maximum; this usually occurs in this particular cupola at the 30° points on each side of the tuyères, so that it is not necessary to probe the cupola for the maximum. In case of an evident hole at some other location this maximum is reported.

Daubing materials can be tested in the same way by daubing up the melting zone of the cupola after the test heat or after any number of regular heats, as the author uses this cupola a great deal for experimental mixture work. Test 3 is an example of such a test and is described fully in the text.

Some Test Runs

Three tests run at the American Cast Iron Pipe Company are given.

Test 1 was run with split brick, since arch brick of this particular brand were not available. Also an error was made as the two linings were put over the two tuyères instead of being split on the tuyères as is our common practice. The results of the tests show, however, that the two practically are on a par in regard to the melting zone of the cupola and if there was any difference, brick "E" was apparently more desirable. This brick was put into service in the daubing of the main pipe foundry cupolas and a record was kept of one cupola which was daubed with brick "E" and another which was daubed with brick "F," the service being identical in any considerable number of runs, although there might be some variation in a small number. It was found after a careful check had been kept for a month that the number of brick required during the period for daubing was exactly the same in both cases, thus substantiating the test data.

Test 1

PENETRATION TEST IN NO. 0 CUPOLA ON SPLITS OF BRICKS S (STANDARD) AND E (PROPOSED)

Lined with splits of Brick S on south side and with splits of Brick E on north side, both laid in Riverside clay.

Cupola carefully dried, put up with Bradford coke bed and charged with bottom coke, cupola chipping, borings, turnings, and limestone. Heat started at 10:10 A.M. and bottom dropped at 12:50 P.M.

Profile readings include penetration from original inside brick surface.

	S. E. (in.)	S. (in.)	S. W. (in.)	N. W. (in.)	N. (in.)	N. E. (in.)
Middle of tuyères	1 1/2	1	1 1/4	1 3/4	3/4	1 1/2
2 in. above middle	1 1/2	2	2 3/4	2 1/4	1 3/4	2 1/8
6 " " "	1 1/8	2	1 1/4	1 3/4	1 1/2	1 3/8
10 " " "	1/2	3/4	3/4	1 3/8	7/8	1/2
16 " " "	1/4	3/8	1/4	1	3/8	1/4

Average Brick S	1.25 inch
Average Brick E	1.25 "
Maximum Brick S	2.75 "
Maximum Brick E	2.25 "

Test 2 shows an Olive Hill brick on one side of the cupola and standard on the other side, which was also brick "S" in Test 1. Here the Olive Hill proved to be vastly superior to the standard brick which had been giving service for about 6 months in daily operations of 10- to 12-hour heats. One of the cupolas was lined with Olive Hill block and gave 15 months' service, this being somewhat better than would have been expected from the tests.

Test 2

PENETRATION TEST IN NO. 0 CUPOLA ON OLIVE HILL* AND STANDARD BRICK

	S. W. (in.)	W. (in.)	N. W. (in.)	N. E. (in.)	E. (in.)	S. E. (in.)
2 in. above tuyères	2	3	1 1/4	1 1/2	1 3/4	1
5 " " "	3 1/4	1 1/2	2 1/2	1 1/2	1 1/2	1 3/8
9 " " "	1 1/2	3/4	1 3/4	1	5/8	3/8
15 " " "	1	1/2	1	3/4	1/4	3/8
24 " " "	1/4	0	1/4	0	0	0

* Not a trade name.

Olive Hill bricks were on the east side, and standard on the west side of the circle and measurements were taken every 60°. The two tuyères were on the north and south.

The summary shows penetrations as follows:

Average Olive Hill	1.1 in.
Average standard	1.7 "
Maximum Olive Hill	1.8 "
Maximum standard	3.3 "

Test 3 was a daubing test between ordinary shale fire clay and a very plastic fire clay containing 90% silica. After this test we had no question in adopting the Riverside clay for our cupola daubing and are still using it after a period of about six years and find it undoubtedly the best material obtainable for this purpose.

Test 3

TEST OF HIGH SILICA AND ORDINARY SHALE CLAY AS DAUBING IN NO. 0 CUPOLA

Cupola lined with 4 1/2 inches of standard brick had been cut out very evenly to a depth of 1 1/2 inches. The east side was daubed with the Riverside mixture, 1/2 clay and 1/2 silica sand; the west side with the shale clay mixture in the same proportions. After the test the average thickness of the east lining was 3 1/2 inches while that of the west side was 2 1/2 inches.

Melting Zone Test not Sufficient

In using a test cupola for testing cupola refractories it should be borne in mind that the point of test here is only the melting zone itself, and that the abrasion in the upper part of the stack running a long heat is sometimes more important from the refractory standpoint than the melting zone itself. In fact, in our own case the brick after the third heat are seldom fluxed at all as all of the burden of carrying the daily heat falls on the daubing itself.

Above the melting zone this problem is vastly complicated by the mechanical attrition of the charge, and the actual pounding of such heavy material as pig iron. Here it is impossible to simulate service conditions, and although a refractory may show slightly better in a melting zone test it may not be so satisfactory in service where strength is required to withstand the mechanical action of the charge.

AMERICAN CAST IRON PIPE COMPANY
BIRMINGHAM, ALABAMA

A NEW TYPE HIGH TEMPERATURE FUSION FURNACE[1]

By J. B. Shaw and G. J. Bair

ABSTRACT

The limitations of carbon, gas, and electric furnaces for high-temperature fusion are discussed. The new oxyacetylene furnace controls the atmosphere in contact with the test cones, protects furnace parts, and insures uniform conditions throughout the furnace.

Introduction

Difficulties in firing multiply rapidly as the temperature of operation rises. In the field of high temperatures required for fusion-point determinations all kinds of difficulties are encountered and the accuracy and value of results obtained depend very largely upon the efficiency with which they are overcome.

The object of this paper is to illustrate briefly a new design of furnace used for the determination of fusion point or P.C.E. value.

The Furnaces in Use

The old Deville furnace, using carbon with compressed air, was the standard equipment twenty years ago for high-temperature fusion. It is still used in some places when gas is not available. The uncertainty of reaching the desired temperature and impossibility of regulating the atmosphere makes it impossible to comply with conditions specified in standard tests of clays.

Electrically heated fusion furnaces have never been very satisfactory. Hot spots always develop in the granular resistance and the carbon plate type of furnace. These hot spots result in the destruction of the refractory parts of the furnace and in variable temperatures.

Natural gas has been used with good results in several different types of furnaces and when oxygen is used with the gas, cone 40 can be fused with little difficulty.

The oxy-acetylene or oxy-hydrogen flames have been adopted for high temperature work where natural gas fuel is not available and in fact they are used in some cases in preference to natural gas.

While these gas-fired furnaces are susceptible to more accurate control than the old Deville furnace or the electric furnace, they have certain inherent features that make them troublesome to operate and cause results always to be questionable.

The Gas-Fired Furnace

The character of the atmosphere in contact with the test specimen, whether oxidizing or reducing, must be known. Standard tests specify

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.)

that the fusion must be made in a neutral or oxidizing atmosphere. The flame from the gas burner completely surrounds the test cones in all fusion furnaces of which the writer has knowledge. A gas flame, either natural gas or acetylene, of sufficient volume to surround the cone pat at cone 40 is difficult to maintain oxidizing.

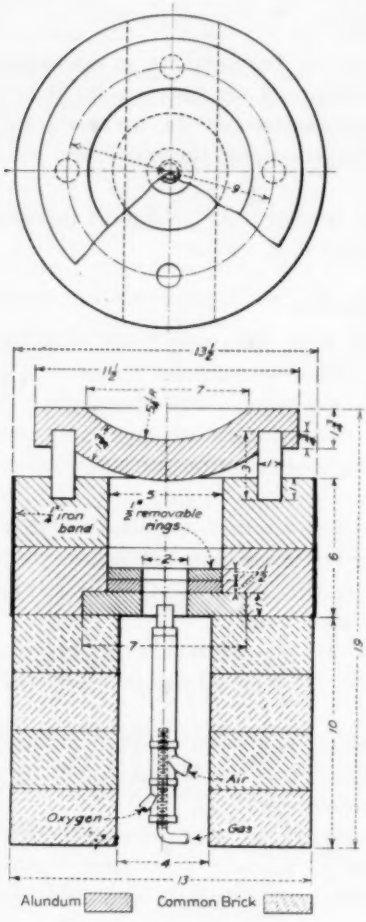

FIG. 1.—Fusion furnace.

The most objectionable feature of the gas-fired furnace is the difficulty of keeping the refractory parts in shape; this is especially true when acetylene or hydrogen is used. The flame impinges on the bottom or side of the refractory parts of the furnace and the intense temperature of the flame results in rapid destruction of these parts.

Oxyacetylene Furnace

The furnace shown in Fig. 1 was designed as a result of many years' experience with several other types. The aim in designing it was to make it possible to control the atmosphere in contact with the test cones and at the same time protect the furnace parts and insure uniform conditions throughout the furnace.

In the first fusion furnace designed the flame entered the bottom of a cylindrical furnace (3 inches inside diameter). The flame impinged directly onto the bottom of the cone pat which was supported in the middle of the furnace by three magnesia bars projecting through the walls of the furnace. In this furnace the flame often cut through the alundum cone pat before the cones fused. When this did not occur, the results obtained were doubtful because of the difficulty of maintaining a uniform temperature and an oxidizing atmosphere.

To correct these faults the design of the cone pat was changed to a ring-shaped pat so as to permit the flame to pass through the center of the cone pat and impinge on the cover without touching the cones. With

this arrangement in the original furnace it was found difficult to obtain temperatures desired because the top was too far from the cones and too much cold air was drawn in around the outside of the cone pat, cooling the cone.

Final Design The furnace described in this paper was built to correct these imperfections. The height of the furnace has been reduced from 8 inches to $2^1/_2$ inches. In this way, the hottest part of the flame is at the point where it meets the cover; the products of combustion pass from there directly out of the furnace under the cover. The cones are heated entirely by radiation.

Cover It was with much trouble that a cover of proper design and material was obtained. It was found that a convex cover of the design illustrated gave higher and more uniform temperatures. It can be easily adjusted for proper height to give the desired rate of heating and atmospheric conditions by moving the triangular supports closer together or farther apart.

To find something which would stand the severe treatment required of this cover, many materials were tried. Magnesia and high temperature alundum cements spalled as soon as the flame struck them. The low temperature alundum cement fused. A cover made of granular silicon carbide bonded with 5% ball clay has proved more satisfactory than any yet tried. A cover of this material has lasted over 100 fusions.

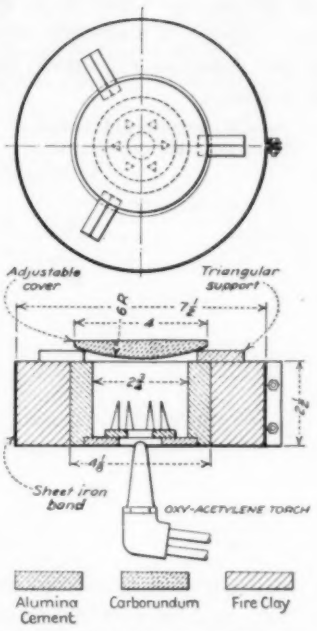

FIG. 2.—High temperature fusion furnace.

Result This furnace using oxyacetylene flame has been used for more than a year with excellent results. The furnace of the same design but larger and for use with city gas or natural gas has not been used but from results obtained using acetylene gas it is believed that it will prove entirely satisfactory.

Burner Equipment The burner and equipment used in the Department of Ceramics at Pennsylvania State College are as follows:

1 No. 146 welding torch complete with No. 6 and No. 7 tip
1 Style 5101 oxygen regulator complete with 50- and 3000-lb. gages
1 Style 5102 acetylene regulator complete with 50- and 400-lb. gages
1 22-ft. length $^5/_{16}$ in. ply red oxygen hose

1 25-ft. length $^{4}/_{16}$ in. one ply black acetylene hose
4 $^{1}/_{4}$-in. hose clamps

The approximate cost of this equipment is $75.00.

No figures are available for cost of making fusions in this furnace but it can be said that it operates very efficiently and fusions can be made much more rapidly than is permissible under standard specifications.

Oxygen and acetylene cylinders are rented at nominal cost. Acetylene costs $3.35 per 100 cu. ft., in 250 cu. ft. cylinders. Oxygen costs $1.60 per 100 cu. ft. in 250 cu. ft. cylinders. It may be roughly estimated that one cylinder of acetylene will require two cylinders of oxygen and under proper conditions it should be possible to make 30 fusions per cylinder of acetylene.

PENNSYLVANIA STATE COLLEGE
STATE COLLEGE, PENNSYLVANIA

THE RELATION OF A MODULUS OF GRAIN SIZE TO THE MECHANICAL STRENGTH OF SAGGER MIXTURES[1]

By Raymond E. Birch[2]

ABSTRACT

A series of sagger mixtures is prepared with grain size varied on a calculated fineness modulus. Both dry and fired strength are related to grain size and a striking maximum point is obtained.

Introduction

This thesis shows the relation of the modulus of rupture of sagger bodies to "fineness modulus" of grain size. The fineness modulus is used to indicate the size and grading of concrete aggregates. The percentage of the aggregate either by weight or volume coarser than each sieve determines the fineness modulus.

Calculation of Fineness Modulus

Mesh		Example No. 1		Example No. 2	
		Per cents on	Cumulative per cents	Per cents on	Cumulative per cents
Through	4 on 8	10	10	1.5	1.5
Through	8 on 16	10	20	2.0	3.5
Through	16 on 30	10	30	3.0	6.5
Through	30 on 50	10	40	2.0	8.5
Through	50 on 100	60	100	91.5	100.0
			Sum = 200		Sum = 120.0

The sum of the percentages of grog larger than each mesh in No. 1 is 200. This divided by 100 gives a fineness modulus equal to 2.0. In No. 2 the fineness modulus is 1.2.

The Investigation

Screens of 4, 8, 16, 30, 50, and 100 meshes per lineal inch were used. With all grog crushed to pass a 4-mesh and discarding all that passed through a 100-mesh sieve, it is evident that the classification modulus range is from 1.0 to 5.0. It would be 1.0 when all grog passed 50-mesh and stopped on 100-mesh and 5.0 with all grog passing through 4-mesh and stopping on 8-mesh.

All body mixtures had composition by weight of

50% grog (from fire brick)
20% Old Hickory sagger ball clay (Old Hickory, Ky.)
15% sagger ball clay (Mayfield, Ky.)
15% Lower Kittanning fire clay (Morgan and Horton Co.)

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Terra Cotta Division.) Received January 12, 1929.

[2] Thesis for degree of Bachelor of Science in Ceramic Engineering, Ohio State University, 1927. Research Engineer, The Ohio State Univ., Clay Products Experimental Station, Roseville, Ohio.

Twenty-four bars were made from each mixture, twelve to be broken dry, and twelve to be fired to cone 8 and broken.

TABLE I
SIEVE ANALYSIS AND CLASSIFICATION MODULUS OF GROG

Mixture no.	Per cent larger than each sieve					Classification modulus
	8	16	30	50	100	
A	0	0	0	0	100.00	1.0
B	2.50	7.50	15.00	25.00	100.00	1.5
C	5.00	15.00	30.00	50.00	100.00	2.0
D	16.25	28.75	43.75	61.25	100.00	2.5
E	27.50	42.50	57.50	72.50	100.00	3.0
F	38.75	56.25	71.25	83.75	100.00	3.5
G	50.00	70.00	85.00	95.00	100.00	4.0
H	75.00	85.00	92.50	97.50	100.00	4.5
I	100.00	100.00	100.00	100.00	100.00	5.0

Results

Plotting these moduli a striking maximum point for Mixture B was obtained. It is important to determine if this was merely a singularity due to blending of various grog mixtures, or a characteristic of grog of this fineness modulus.

Four additional mixtures of wide size variation were prepared, each having a classification modulus of 1.5. Mixtures A and C (moduli of 1.0 and 2.0, respectively) were also compounded again for use as reference points.

The four new bodies are given with compositions in Table II.

TABLE II
SIEVE ANALYSIS AND CLASSIFICATION MODULUS OF GROG

Mixture no.	Per cent larger than each sieve					Classification modulus
	8	16	30	50	100	
B_1	2.50	7.50	15.00	25.00	100.00	1.5
B_2	4.00	8.00	13.00	25.00	100.00	1.5
B_3	0.50	11.00	16.00	22.00	100.00	1.5
B_4	10.00	11.00	13.00	16.00	100.00	1.5

TEST DATA ON BARS
(24 bars of each mixture hand molded 6 by 1 by 1 inch)

Mixture and classification modulus	Modulus of rupture	
	Av. of 12 dry bars (lbs.)	Av. of 12 bars fired at cone 8 (lbs.)
A = 1.0	210.4	1477.0
B = 1.5	221.0	1936.0
C = 2.0	207.0	1642.6
D = 2.5	188.0	1588.0
E = 3.0	177.1	1452.0
F = 3.5	133.7	1187.0
G = 4.0	103.5	826.0
H = 4.5	85.7	561.0
I = 5.0	76.3	417.0

CHECK TESTS ON MIXTURES A, B, AND C

Mixture and classification modulus	Modulus of rupture	
	Av. of 12 dry bars (lbs.)	Av. of 12 bars fired at cone 8 (lbs.)
A = 1.0	147.0	1774.0
B = 1.5	164.0	1987.0
C = 2.0	150.7	1748.0

CHECK TESTS ON MIXTURES B AS PER TABLE II

Mixture and classification modulus	Modulus of rupture	
	Av. of 12 dry bars (lbs.)	Av. of 12 bars fired at cone 8 (lbs.)
B_1 = 1.5	164.0	1987
B_2 = 1.5	203.0	1835
B_3 = 1.5	222.1	2051
B_4 = 1.5	177.0	2252

Interpretation of Data

Dry Bars Results on the initial series of sagger bodies (Nos. A to I inclusive) reveal that in general the modulus of rupture varies inversely with the classification modulus, until a maximum value is reached with body B, a fineness modulus of 1.5. The modulus of rupture for this body however is not distinctly larger than for some others. In fact, it is entirely worth noting that the dry modulus of rupture decreases rather slowly with increase in the classification modulus from 1.0 to 3.0. From this point, however, the transverse strength drops abruptly as the classification modulus increases.

The four grog mixtures with classification modulus equal to 1.5 (B_1, B_2, B_3, and B_4) gave modulus of rupture values greater than those for A_1 and C_1, which were compounded at the same time. All of these values, for some unexplained reason were lower than those obtained for the same bodies in the initial series. Perhaps undue weight should not be placed on this inconsistency, since the modulus of rupture values maintain the same relative positions with regard to the classification modulus.

Fired Bars As was the case with the dry bars of the initial series, the fired test pieces also showed a maximum transverse strength development in the sagger body with classification modulus equal to 1.5. As the modulus increases above 1.5, the modulus of rupture decreases abruptly. This maximum strength with modulus of 1.5 was reaffirmed by the results of the second series, which contains the four bodies with that classification modulus. It should be noted that while these mixtures vary widely in regard to actual grain size composition, there is very slight variation in the modulus of rupture, at least in the fired product. Here the variance from the mean modulus of rupture is only 2.9% as an average.

TABLE III

Mix no.	Classification modulus	Modulus of rupture of dry bars	Variance from mean	Modulus of rupture of fired bars	Variance from mean
B_1	1.5	164	14.8%	1987	4.9%
B_2	1.5	203	5.5	1835	2.9
B_3	1.5	222	15.3	1864	1.3
B_4	1.5	177	7.5	1876	0.7
Averages		192.5	8.3%	1890	2.9%

Conclusion

On the basis of the results noted previously, we may conclude that, with other factors being the same:

(*a*) The strength of sagger bodies is related to the grain-size classification modulus of the grog.

(*b*) Batches of grog having the same classification modulus will produce sagger bodies of approximately the same fired transverse strength.

(*c*) Grog mixtures having classification moduli of about 1.5 will make the strongest saggers, both in the dry state and when fired.

OPTICAL METHODS AS AN AID TO THE STUDY OF REFRACTORIES[1]

By T. N. McVay[2]

ABSTRACT

The application of the petrographic microscope as an aid to the study of designating impurities in raw materials has proved successful. By the same methods fired refractories may be classified and the effects of bonds tested. Optical tests should chiefly be used to supplement and not to displace other methods of examinations.

Any means which will give information designating the impurities present in raw materials or showing the cause of failure of refractories under various conditions of service is of assistance to the manufacturer as well as to the user of such materials.

For most examinations it is sufficient to crush the material to a powder and examine the grains by placing them in oils of predetermined refractive indices, this being the most useful method for the identification of minerals and often gives an idea of the structure. For a study of structure alone, however, the use of thin sections is better and these can be obtained at a comparatively low cost.

The materials from which refractories are made are necessarily of various mineralogical compositions and may contain numerous minerals some of which may be injurious to the finished product, examples being the presence of calcium carbonate in clays and of quartz in cyanite. Such minerals as these are readily identified by one who is experienced in the use of the petrographic microscope. This means of examination is of particular value for one who is prospecting for minerals which may be of economic importance. As is very often the case, such minerals are not readily determinable by macroscopic examination; thus considerable labor can be saved the analytical chemist or at least he may be given an idea of what elements are present in the material.

Optical methods are of much greater use in studying the pyrochemical behavior of refractory bodies on heating and it is particularly true that the more severe the service and the greater the temperature to which these materials have been subjected the easier are their examination. Some of the important reactions which may be studied are as follows:

The progress of vitrification may be studied and this is of particular value when several ingredients are used which must be combined in order to have a high grade heat-resisting material.

The approximate amount of mullite formed and the size of the individual crystals can be determined and also the approximate amount of glass. The size of the mullite crystals increases with the temperature of firing

[1] Presented at the Annual Meeting of the American Ceramic Society, Chicago, Ill., February, 1929. (Refractories Division.)

[2] Professor of Ceramics, University of Alabama.

and also within limits with the amount and viscosity of the glass present.

The effect of slags on refractories can be determined and those ingredients which are least suited to withstand the action of slags can be recognized. Such examinations may help in some cases to furnish data for the writing of specifications and will also give information as to the reason why certain materials fail in service.

The amount of alteration of the quartz in silica brick or in high silica fire brick may be found in an approximately quantitative manner. The rate of change of diasporite into corundum and its further change into mullite when in contact with silica or glass, an interesting transition, can also be determined.

The alteration of andalusite, cyanite, and sillimanite at high temperatures and their changes into mullite have been investigated and much practical and fundamental information obtained.

By this means fired refractories may be examined and their type determined, that is, they can be divided into several classifications namely: fireclay type either high or low in silica, fireclay type with the addition of diaspore, high aluminous refractories, silica refractories, special refractories.

One of the most interesting uses of the microscope is in the study of the effect of bonds in refractories since, within limits, with regard to its load-carrying capacity at high temperatures, a brick is only as good as its bond. The effect of the addition of different bond clays may be examined after laboratory tests or after actual service conditions and in some cases it will be found that the addition of finely-ground refractory materials to the bond will cause it to have a greater viscosity and thus have greater load resistance at high temperatures.

These are but a few of the applications of the petrographic microscope to the refractory field. It must not be considered that optical methods are a "cure all" or that they will displace other methods of study and testing. Its real use should be to supplement other methods of examination.

There are some problems which may be studied to a better advantage by other methods; especially is this true where the refractories have been subjected to comparatively low temperatures in firing or in service. In such cases the quartz grains, if present, may show little or no alteration to other forms of SiO_2 and yet the thermal expansion curves will show a marked cristobalite inversion, this being due to the fine-grained submicroscopic material which cannot be observed even with the highest magnification. Such materials can be studied to a much better advantage by means of X-rays or thermal expansion curves.

PROGRESS REPORT ON INVESTIGATION OF SAGGER CLAYS. V.

Preparation of Experimental Sagger Bodies According to Fundamental Properties[1]

By R. A. Heindl and L. E. Mong

ABSTRACT

This is a Fifth Progress Report giving the results obtained in a preliminary study of sagger bodies, which is a continuation of an extensive investigation of sagger clays for the purpose of determining the properties of clays and bodies best suited for sagger purposes. The report contains data on the modulus of elasticity, transverse breaking strength, plastic flow, thermal expansion, and resistance to failure due to heat shock of 55 sagger mixes representing 39 different bodies fired at either 1230°C or 1270°C. The 16 bodies prepared in duplicate were tested both after firing at 1230°C and 1270°C. All of these bodies were compounded with two clays whose properties are given in earlier progress reports, and a mixture of graded grog. The grog was graded into sizes so as to result in two types of bodies, those having (1) a coarse and open-grained structure and (2) a dense and fine-grained structure. The data on the fired bodies show that those containing the fine sizes of grog have the higher modulus of elasticity, transverse strength, and in the majority of cases, thermal expansion. Very little difference in total porosity of the two types of bodies is indicated although the rate of absorption shows large differences. The data obtained in this preliminary study indicate that those bodies having (1) a porosity of less than 25%, (2) a low modulus of elasticity, (3) as high transverse strength as is compatible with the low modulus of elasticity, and (4) low thermal expansion below 250°C, are the most desirable for sagger purposes.

I. Introduction

In the first Progress Report[2] of the sagger investigation data were given which served as a basis for the grouping and classification of fifty-one sagger clays into five divisions according to their firing characteristics. Thermal expansion of the clays was studied and the results of the observations published in the Second Progress Report.[3] Based on the results reported in the first two Progress Reports, seventeen clays representative of the five groups were selected for future work on this subject. The transverse strength and changes in deformation with increments of load were observed for each of these seventeen clays at (*a*) room temperature, (*b*) the temperature (ranging from 350 to 925°C) at which saggers made from these clays failed in an air-quenching test described in the First Report, and (*c*) at 750°C. The results of these tests were published in a Third Progress Report.[4] The results of tests similar to those described in the Third Report but made at 1000°C, together with some observations

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce. Received May 20, 1929.

[2] *Jour. Amer. Ceram. Soc.*, **9** [3], 131–43 (1926).

[3] *Ibid.*, **9** [9], 554–74 (1926).

[4] *Ibid.*, **10** [7], 524–34 (1927).

of the elastic and plastic characteristics of the various fired clays were reported in a Fourth Progress Report.[5]

Recent studies included the preparation of sagger bodies, based on the fundamental data already reported, the making of small experimental saggers, and the determination of the physical properties of the fired saggers and sagger bodies. This paper contains the results of these tests which were made on thirty-nine different sagger bodies fired at two different temperatures as well as on eight sagger bodies furnished by pottery manufacturers.

II. General

A study of the sagger body compositions used by forty pottery and tile manufacturers shows a large variation in the number and percentages of different clays used and percentage and sizing of grog. It also shows that the "rule-of-thumb" practice is largely followed in the compounding of sagger bodies. The number of clays used in any one body varies from two to four and the amount of grog in the various bodies ranges from approximately 30 to 60%. The majority of sagger mixes fail to show any definite sizing or grading of grog. In some cases the grog is simply crushed to pass a sieve with fairly large openings, while in others only the coarse grog is used. In general, the raw clay content of most sagger mixtures consists of one or more dense-firing or vitrifying clays and one or more porous and comparatively refractory clays, with varying percentages and sizes of grog.

The possible variations in clay combinations, sizing, percentage and porosity of grogs, and firing temperatures is practically unlimited with the many sagger clays on the market. It was, therefore, necessary to limit this study to the making and testing of such body compositions from the seventeen representative clays as might result in data of most value for preparing saggers of maximum life.

III. Sagger Body Compositions

The initial study of the compounding of sagger bodies included the blending of two clays in equal parts by weight mixed with equal proportions by weight of grog prepared from each clay. One of the clays when fired had a high porosity and the other a somewhat lower porosity. The grogs used in these mixes were fired at approximately 1230°C (cones 9 to $9^1/_2$) for $1^1/_2$ hours. This procedure was varied in several instances by using grog separately prepared from only one of the clays, *i.e.*, the porous or the dense-firing clay. With one exception, only clays having the same general type of thermal expansion below 200°C were used in a body, that is, each of the clays making up a body was taken from either

[5] *Jour. Amer. Ceram. Soc.*, **10** [12], 995–1004 (1927).

Group H or Group L.[6] The sagger body numbers, the clays and grogs making up the various bodies, and the properties of these clays fired at 1230°C are given in Table I.

TABLE I

DATA ON CLAYS[a] FIRED AT 1230°C USED IN SAGGER BODIES

Sagger body numbers	Number of clays in sagger bodies	Grog No.	Belong to group [b]	Porosity (%)	Tested at 20°C: Modulus of Rupture lbs./sq. in.	Tested at 20°C: Modulus of Elasticity 1000 lbs./sq. in.	Saggers made from single clays cracked at (°C) –
1F, 1C, 1aF, 1aC	24	24	H	29	2180	2770	570
	37	37	H	3	3920	9430	480
2F, 2C, 2aF, 2aC	24	24	H	29	2180	2770	570
	32	32	H	13	2310	5610	515
3F, 3C, 3aF, 3aC	19	19	H	34	1380	1530	800
	32	32	H	13	2310	5610	515
4F, 4C, 4aF, 4aC	19	19	H	34	1380	1530	800
21SF, 4XF, 4XC	24	24	H	29	2180	2770	570
5F, 5C, 5aF, 5aC	5	5	L	22	3140	4910	370
1X, 1C	41	41	L	36	2350	3110	350
6F, 6C, 6aF, 6aC	6	6	L	32	600	889	410
20SF, 2XF, 2XC	25	25	L	34	2450	3570	495
7F, 7C, 7aF, 7aC	15	15	H	15	3305	5210	580
3XF, 3XC	42	42	H	24	1460	2230	745
15S	5	5	L	22	3140	4910	370
8F, 8C, 8aF, 8aC	16	16	L	42	635	934	1000
9F, 9C	15	15	H	15	3305	5210	580
	42		H	24	1460	2230	745
10F, 10C	6	6	L	32	600	889	410
	5		L	22	3140	4910	370
11F, 11C	41	41	L	36	2350	3110	350
	35	35	H	14	3360	3360	575
12F, 12C	24	39	H	29	2180	2770	570
	39		H	19	3370	5090	565
13F, 13C	18	49	L	17	3010	5950	405
	49		L	37	1710	2370	460
14F, 14C	18	18	L	17	3010	5950	405
	49	49	L	37	1710	2370	460

[a] Complete chemical and physical properties of these clays have been given in the four progress reports already published on this investigation (*loc. cit.*).

[b] The Second Progress Report (*loc. cit.*) classed the clays according to rate of thermal expansion below 200°C into Groups H and L.

The majority of the bodies were prepared in two series as similar as possible in every respect with the exception of the sizes of the grog. One series compounded with comparatively coarse sizes of graded grog was designated as "C" and the other series compounded with the finer sizes of graded grog was designated as "F." Two combinations of grog sizes

[6] The "Second Progress Report (footnote 2) on Investigation of Sagger Clays," states that the clays have been classed in two groups according to thermal expansion behavior between 100 and 200°C; clays classed in Group L showed a decided increase in the rate of expansion, while clays of Group H showed a very small, or in the majority of cases, no increase in rate of expansion.

were taken from those recommended by Kirkpatrick.[7] The one, consisting of the relatively coarser sizes of grog, was recommended if resistance to repeated heating and cooling is desired more than strength. In the other, finer sizes are used and resistance to repeated thermal shock is sacrificed to obtain bodies of greater strength.

In the two primary combinations used, the grog sizing and the percentage of each size are as follows:

Material	Sieve No.		Per cent of each size
	Passed	Retained	
For coarse grogged body	4	8	20
	8	12	60
	12	20	20
For fine grogged body	20	40	$66^2/_3$
	40	80	$33^1/_3$

The following special combinations of grog were used in one body each ("S" bodies):

(1) Body 15 S. Grog and dust passing an 80-mesh sieve.

(2) Body 21 SF. Grog graded as follows to obtain a dense and strong body.

Sieve Number		
Passed	Retained on	Per cent used
20	40	40
40	80	20
80	200	40

(3) Body 20 SF. Grog approximately graded in accordance with W. F. Fuller's curve[8] to obtain a body especially resistant to thermal shock and also of good strength.

Sieve number		Per cent of each size
Passed	Retained on	
4	8	20
8	12	15
12	20	20
20	40	15
40	80	15
80	200	15

In addition, eight bodies were prepared, four each using the coarse and fine grog combinations, except that the grog was fired for $1^1/_2$ hours at 770°C ± 5°, instead of 1230°C. These bodies ("X" bodies) were so prepared because it has been found that fire clays show a rapid contraction at about 800°C.[9] It was assumed that it might be desirable to use grog which has not been fired higher than this temperature so as to eliminate the strains which are likely to be set up between the bond and grog during

[7] Bur. Stand., *Tech. Paper*, No. 104, p. 38, Table 11.

[8] Concrete, Plain and Reinforced. 1916 edition. By Taylor and Thompson.

[9] "The Behavior of Fire Clays, Bauxites, etc., on Heating," *Trans. Ceram. Soc.* [Eng.], **22,** 111 (1922–1923).

firing if the latter had been first fired at a temperature considerably higher than 800°C.

IV. Description of Specimens

The grog used in the preparation of specimen bars and saggers had been fired in all cases to approximately 1230°C (cone $9^1/_2$). Six bars, 1 x 1 x 12 inches, were prepared for the determination of modulus of elasticity and transverse strength. Specimens measuring approximately 1 x 1 x 6 inches were used for linear thermal expansion studies. These specimens were cut to size from the ruptured 1 x 1 x 12-inch bars used for modulus of elasticity determinations. Six specimens 1 x 1 x 7 inches were made for dry-breaking strength tests; and five (in some cases six) saggers, 4 x 4 x 6 x $^1/_2$ inches were made for the thermal shock tests. The saggers were made oval in shape to more nearly simulate the conditions producing strains in practice. One set of saggers and the 12-inch bars were fired at approximately 1230°C (cones 9 to $9^1/_2$) and another set of each at 1270°C (cones $11^1/_2$ to 12). To simulate industrial conditions which might cause some difference in the properties of the fired bodies, the saggers of any one set were not all made on the same day but on different days. All saggers were fired in the same kiln, a part of each set of five saggers being fired at different times.

V. Methods of Testing and Results

The methods of determining the modulus of rupture, porosity, linear thermal expansion, resistance to thermal shock, modulus of elasticity, and transverse strength at room and elevated temperatures, and the plastic flow at 1000°C have been described in detail in the several previous progress reports.[10] It might be well, however, again to give briefly the method used in the quenching test. Five specimen saggers of each of the bodies were heated at progressively higher temperatures and air-quenched until fracture occurred. The initial quenching was from 350°C, the second 400°C, and for each succeeding quenching the temperature was increased 25°C until the test sagger failed.

(1) Modulus of Rupture, Unfired Bodies

The moduli of rupture of the various sagger bodies, both those prepared in the laboratory and those received from the potteries, are given in Tables II and III.

The average modulus of rupture for the bodies containing the fine grog was found to be 160 pounds per square inch, for the bodies containing the coarse grog 95 pounds per square inch, and for the commercial bodies 75 pounds per square inch.

[10] See footnotes 2, 3, 4, and 5.

TABLE II

PROPERTIES OF SAGGER BODIES FIRED AT 1230°C

Body No.	Numbers of clays in body (x)	Modulus of rupture of unfired body (lbs./sq. in.)	Tested at 20°C: Modulus of Rupture (lbs./sq. in.)	Tested at 20°C: Modulus of Elasticity (1000 lbs./sq. in.)	Tested at 20°C: Computed outer fiber strain (%)	Tested at temperature at which sagger failed in quenching test: Sagger failing at (°C)	Tested at 750°C: Modulus of Rupture (lbs./sq. in.)	Tested at 750°C: Modulus of Elasticity (1000 lbs./sq. in.)	Tested at 750°C: Computed outer fiber strain (%)	Porosity (%)	Coefficient of expansion 20 to 250°C (× 10⁻⁶)	Coefficient of expansion 20 to 600°C (× 10⁻⁶)	Total expansion in per cent of unit length (20–1000°C)	Resistance factor R
1F	24. 37	90	2110	4805	0. 04	640	2000	5515	0. 04	1730	5970	0. 03	17. 3	5. 21	5. 9	0. 52	4. 3
1C	24. 37	50	955	1775	0. 05	835	885	1465	0. 06	1090	2270	0. 05	17. 6	4. 7	5. 6	0. 51	5. 5
2F	24. 32	195	1905	3605	0. 05	560	2205	4630	0. 05	2260	4730	0. 05	19. 9	6. 6	6. 4	0. 55	4. 3
2C	24. 32	75	960	1525	0. 06	680	985	2005	0. 04	830	2690	0. 03	23. 8	6. 6	6. 4	0. 54	4. 2
3F	19. 32	105	1345	1990	0. 07	760	1940	3500	0. 06	1780	4150	0. 04	24. 6	5. 5	6. 2	0. 51	4. 7
3C	19. 32	70	745	1405	0. 05	860	850	1530	0. 06	1140	2640	0. 04	24. 3	7. 5	6. 0	0. 50	4. 0
4F	19. 24	75	1095	1595	0. 07	940	1610	2690	0. 05	1700	2830	0. 06	33. 4	7. 6	7. 2	0. 56	2. 9
4C	19. 24	70	620	890	0. 07	945	910	1580	0. 06	1090	1875	0. 06	34. 2	7. 6	7. 6	0. 58	2. 8
5F	5. 41	205	1505	2490	0. 06	445	1970	3520	0. 06	1820	3880	0. 05	28. 4	8. 9	7. 3	0. 60	3. 0
5C	5. 41	110	645	1545	0. 04	585	805	2260	0. 04	820	2350	0. 04	28. 4	8. 5	7. 0	0. 58	3. 1
6F	6. 25	185	1150	1700	0. 07	550	1620	2850	0. 06	2105	3370	0. 06	31. 6	10. 0	8. 3	0. 62	2. 7
6C	6. 25	150	560	1075	0. 05	610	920	1960	0. 05	920	2810	0. 03	30. 0	9. 3	8. 0	0. 59	2. 2
7F	15. 42	185	1875	3755	0. 05	610	1910	3330	0. 04	2300	6060	0. 04	19. 2	4. 5	5. 4	0. 49	4. 8
7C	15. 42	160	1330	3330	0. 04	690	1355	3330	0. 04	1200	4355	0. 03	16. 6	4. 3	5. 4	0. 49	4. 5
8F	5. 16	135	1315	2220	0. 06	450	1570	2650	0. 06	1660	2670	0. 06	35. 3	8. 9	6. 9	0. 58	2. 9
8C	5. 16	75	510	1000	0. 05	500	720	1270	0. 06	755	1210	0. 06	34. 9	7. 8	6. 5	0. 55	2. 5
9F	15. 42	165	2025	4700	0. 04	565	2020	5280	0. 04	2320	6020	0. 04	17. 3	4. 7	5. 7	0. 50	4. 5
9C	15. 42	105	1175	3160	0. 04	650	1340	4285	0. 03	1275	4000	0. 03	18. 2	4. 3	5. 4	0. 50	3. 8
10F	6. 5	180	1460	2090	0. 07	440	1880	2530	0. 07	2600	4110	0. 06	30. 4	10. 0	8. 6	0. 60	2. 7
10C	6. 5	85	425	540	0. 08	600	750	1350	0. 06	1160	1815	0. 06	33. 0	9. 1	9. 1	0. 63	2. 6
11F	41. 35	250	1525	2405	0. 06	565	1675	3505	0. 05	2200	4000	0. 05	24. 5	7. 0	6. 2	0. 53	4. 0
11C	41. 35	120	660	1340	0. 04	715	770	2280	0. 03	930	2460	0. 04	24. 0	6. 6	6. 1	0. 52	3. 5
12F	24. 39	120	1980	3680	0. 05	535	1865	3030	0. 06	2180	4110	0. 05	25. 7	6. 1	6. 2	0. 53	3. 5
12C	24. 39	80	940	2280	0. 04	615	1200	3140	0. 04	1090	3340	0. 03	24. 2	5. 9	6. 0	0. 51	2. 6
13F	18. 49	130	1510	2020	0. 07	585	1550	2805	0. 06	1370	3220	0. 04	35. 1	6. 7	6. 0	0. 51	3. 7
13C	18. 49	95	690	1390	0. 05	725	1155	2555	0. 05	1050	1825	0. 06	31. 9	6. 4	6. 0	0. 51	2. 7
14F	18. 49	125	1510	2625	0. 06	535	1490	3320	0. 05	1900	3530	0. 05	28. 1	6. 9	6. 4	0. 54	3. 3
14C	18. 49	85	770	1400	0. 06	610	1130	2425	0. 05	950	2520	0. 04	26. 7	6. 8	6. 1	0. 53	3. 4
15S	16. 5	180	2685	3625	0. 07	350	2790	4300	0. 06	2460	4670	0. 05	28. 8	9. 8	7. 5	0. 58	3. 0
1XF	5. 41	170	3250	5335	0. 06	465		5750	0. 05	3670	7010	0. 05	19. 4				
1XC	5. 41	65	1350	2380	0. 06	585	1245	2960	0. 04	1460	3410	0. 04	20. 9				
2XF	6. 25	180	2240	3255	0. 07	445	1510	3620	0. 07	2540	3980	0. 06	29. 6				
2XC	6. 25	75	910	1645	0. 06	590	1530	2960	0. 05	1360	3930	0. 03	29. 0				
3XF	15. 42	260	3985	7185	0. 06	465	3660	7510	0. 05	3700	9165	0. 04	7. 6				
3XC	15. 42	145	1825	3940	0. 05	590	1855	5890	0. 03	1800	6025	0. 03	12. 0				
4XF	19. 24	95	1585	2110	0. 07	625	1890	4070	0. 05	2400	4400	0. 05	31. 4	5. 5	6. 7	0. 53	3. 5
4XC	19. 24	80	1215	1740	0. 07	665	1490	2900	0. 05	1780	3300	0. 05	30. 4	4. 8	6. 5	0. 50	3. 4

(x) Identification numbers of clays correspond to those used in previous reports published on this investigation.

TABLE III

PROPERTIES OF SAGGER BODIES FIRED AT 1270°C

Body No.	Numbers of clays in body (x)	Modulus of rupture of unfired body (lbs./sq. in.)	Tested at 20°C: Modulus of: Rupture (lbs./sq. in.)	Tested at 20°C: Modulus of: Elasticity (1000 lbs./sq. in.)	Tested at 20°C: Computed outer fiber strain (%)	Tested at temperature at which sagger failed in quenching test: Sagger failing at (°C)	Tested at temperature at which sagger failed in quenching test: Modulus of: Rupture (lbs./sq. in.)	Tested at temperature at which sagger failed in quenching test: Modulus of: Elasticity (1000 lbs./sq. in.)	Tested at temperature at which sagger failed in quenching test: Computed outer fiber strain (%)	Tested at 750°C: Modulus of: Rupture (lbs./sq. in.)	Tested at 750°C: Modulus of: Elasticity (1000 lbs./sq. in.)	Tested at 750°C: Computed outer fiber strain (%)	Tested at 1000°C: Modulus of: Rupture (lbs./sq. in.)	Tested at 1000°C: Modulus of: Elasticity (1000 lbs./sq. in.)	Tested at 1000°C: Computed outer fiber strain using: Tangent modulus (%)	Tested at 1000°C: Computed outer fiber strain using: Secant modulus (%)	Porosity (%)	Coefficient of expansion 20 to 250°C (× 10⁻⁶)	Coefficient of expansion 20 to 600°C (× 10⁻⁶)	Total expansion in per cent of unit length (20–1000°C)	Resistance factor "R"
1aF	24, 37	(a)	2280	5980	0.04	580	2430	7210	0.03	2790	..	0.05	4130	740	0.56	0.69	18.1	(a)	(a)	(a)	3.7
1aC	24, 37		1195	3280	0.04	595	1035	3640	0.03	1300	3810	0.03	2210	490	0.45	0.63	16.9				3.9
2aF	24, 32		2180	4205	0.05	525	2340	4890	0.05	2350	5750	0.04	2655	1250	0.21	0.44	20.3				4.1
2aC	24, 32		1130	2340	0.05	565	1370	3540	0.04	1400	3540	0.04	1610	770	0.21	0.44	21.7				3.6
3aF	19, 32		1570	2520	0.06	630	2560	5140	0.03	2440	4770	0.05	3070	1015	0.30	0.46	23.6				4.2
3aC	19, 32		1200	1960	0.06	710	1585	3695	0.04	1740	3650	0.05	1845	820	0.23	0.36	22.9				4.4
4aF	19, 24		1250	1730	0.07	460	1630	2330	0.07	1980	3180	0.06	2940	1280	0.23	0.32	32.6				3.3
4aC	19, 24		1000	1465	0.07	490	1080	1650	0.07	1480	2820	0.05	1980	920	0.22	0.28	32.1				3.1
5aF	5, 41		1720	3220	0.05	400	1660	3950	0.04	2110	4300	0.05	3500	830	0.42	0.62	26.9				2.6
5aC	5, 41		965	1900	0.05	450	925	2300	0.04	935	2440	0.04	1610	555	0.29	0.61	25.5				2.9
6aF	6, 25		1500	1960	0.08	400	1370	2110	0.07	1970	3290	0.06	2710	1120	0.24	0.30	30.3				3.0
6aC	6, 25		765	1180	0.07	490	1030	1770	0.06	1040	1970	0.05	1550	785	0.20	0.51	31.0				2.7
7aF	15, 42		2095	5370	0.04	550	3400	6520	0.05	2910	5860	0.05	4650	470	0.99	1.27	16.2				4.7
7aC	15, 42		1150	4180	0.03	565	1740	4410	0.04	1500	3650	0.04	775	230	0.34	1.77	16.2				3.3
8aF	5, 16		1590	2240	0.07	400	2190	2970	0.07	1760	2910	0.06	2790	1190	0.23	0.26	35.6				2.6
8aC	5, 16		1025	1430	0.07	450	1210	2065	0.06	1200	2120	0.06	1325	785	0.17	0.26	34.3				3.2
20SF	6, 25	70	1050	1675	0.06	460	1285	2150	0.06	1740	2940	0.06	2080	1105	0.19	0.25	30.7	8.9	8.1	0.59	2.5
21SF	19, 24	55	1485	1860	0.08	455	1830	2310	0.08	2200	3010	0.07	3840	1085	0.35	0.38	33.3	7.4	7.4	0.56	3.4
COMMERCIAL BODIES																					
A	...	110	1215	2890	0.04	470	1350	3180	0.04	1630	3880	0.04	1920	940	0.20	0.29	26.3	8.5	7.2	0.57	2.2
B	...	85	1200	2465	0.05	485	1380	2940	0.05	1620	3400	0.05	2350	1360	0.17	0.24	27.1	8.8	7.0	0.56	2.6
C	...	90	945	1620	0.06	680	915	2810	0.03	1150	2010	0.06	..	..	..	..	23.7	9.0	7.8	0.57	3.3
D	...	..	1415	3160	0.04	415	1960	4820	0.04	..	..	..	..	..	..	..	25.6	9.5	7.3	0.59	2.3
E	...	95	855	1355	0.06	615	1110	2480	0.05	1420	2450	0.06	1580	730	0.22	0.58	29.9	8.2	7.0	0.54	3.0
F	...	55	660	1730	0.04	430	1170	1780	0.07	1360	2850	0.05	1035	685	0.15	0.24	29.3	6.9	6.3	0.52	2.2
G	...	55	1070	2290	0.05	440	1055	2630	0.04	925	2980	0.02	1780	735	0.24	0.50	27.9	8.6	6.9	0.58	2.3
H	...	40	750	1150	0.07	645	1200	2390	0.05	..	..	..	1130	405	0.28	0.65	26.6	7.1	6.3	0.52	3.9

(a) Values for Bodies 1aF to 8aC inclusive were considered the same as those given in Table II for Bodies 1F to 8C, respectively.
(x) Identification numbers of clays correspond to those used in previous reports published on this investigation.

(2) Porosity The porosities of the sagger bodies fired at 1230°C are given in Table II and those of the bodies fired at 1270°C are given in Table III. The range in porosity, for the bodies fired at 1230°C, is from approximately 8 to 35.5% and for the bodies fired at 1270°C from 16 to 35.6%. As stated earlier in this report, there is considerable difference in the sizes of the grog used in the preparation of coarse- and fine-grogged bodies. A macroscopic examination of the texture of the sagger bodies also shows a decided difference in structure of the fine- and coarse-grogged bodies. In practically all cases very little difference in porosity was found for any pair of bodies of the same key number whether the grog was fine- or coarse-grained. Consequently, the relative pore size of the fine- and coarse-grogged sagger bodies was determined by measuring the rate of absorption of the bodies after complete immersion in water at room temperature for intervals of 5 minutes, one hour, and 48 hours. The results given in Table IV of the tests made on specimen bars show large differences in porosity of bodies fired at 1270°C.

TABLE IV

RATE OF ABSORPTION (PORE SIZE) IN TERMS OF POROSITY

(Bodies fired at 1270°C)

Body No.	Results obtained after immersing specimens			Total porosity (%)
	5 Minutes (%)	1 Hour (%)	48 Hours (%)	
1aF	3.83	6.55	7.60	16.1
1aC	9.53	9.64	10.45	17.6
2aF	2.84	5.60	9.56	18.8
2aC	12.60	12.50	15.65	18.5
3aF	7.55	14.75	16.85	24.8
3aC	12.68	13.91	17.95	24.5
4aF	17.54	26.25	28.17	32.4
4aC	25.03	25.32	28.00	31.3
5aF	13.98	14.32	17.12	25.6
5aC	17.25	17.08	18.52	25.1
6aF	17.25	24.32	25.90	31.9
6aC	23.30	22.65	26.76	31.7
7aF	2.43	4.82	2.15	15.2
7aC	8.75	8.72	9.55	15.7
8aF	20.20	27.90	29.30	34.6
8aC	26.80	26.70	28.75	33.3
20SF	18.83	24.85	27.00	31.2
21SF	16.00	27.95	29.65	33.8

(3) Linear Thermal Expansion The average coefficient of linear expansion between 20°C[11] and 250°C, 20°C, and 600°C, and also the total expansion at 1000°C in per cent of unit length are given in Table II for the specimens fired at 1230°C, and in Table III for certain specimens fired at 1270°C. The results obtained on the 30 bodies fired at 1230°C indicate that, when blending two clays and grog

[11] The average room temperature was approximately 20°C during these experiments.

prepared from either one or both clays, the resulting expansion behavior of the mixture may fall into one of the three following classes:

(1) It may be greater than the expansion of either clay contained in the body. In this group are included Bodies 2F, 2C, 4F, 4C, 12F, and 12C.

(2) It may be approximately equal to the average expansion of the clays making up the body. This group contains Bodies 3F, 3C, 4XF, 4XC, 6F, 6C, 10F, 10C, 11F, and 11C.

(3) It may be approximately the same as that of the clay in the body having the lower expansion. Bodies 1F, 1C, 5F, 5C, 7F, 7C, 8F, 8C, 9F, 9C, 13F, 13C, 14F, and 14C are in this group.

An illustration of the expansion behavior of bodies grouped in Class 1 is shown at the top of Fig. 1. Full-line curves represent the linear thermal expansions from 20°C to 1000°C of each of the two clays used in the preparation of Bodies 4F and 4C and broken line curves, those obtained on these bodies. The curves for the bodies are practically identical in this instance. Since all the bodies in Class 1 contain Clay 24, it would appear that this clay when blended with another clay and the grog

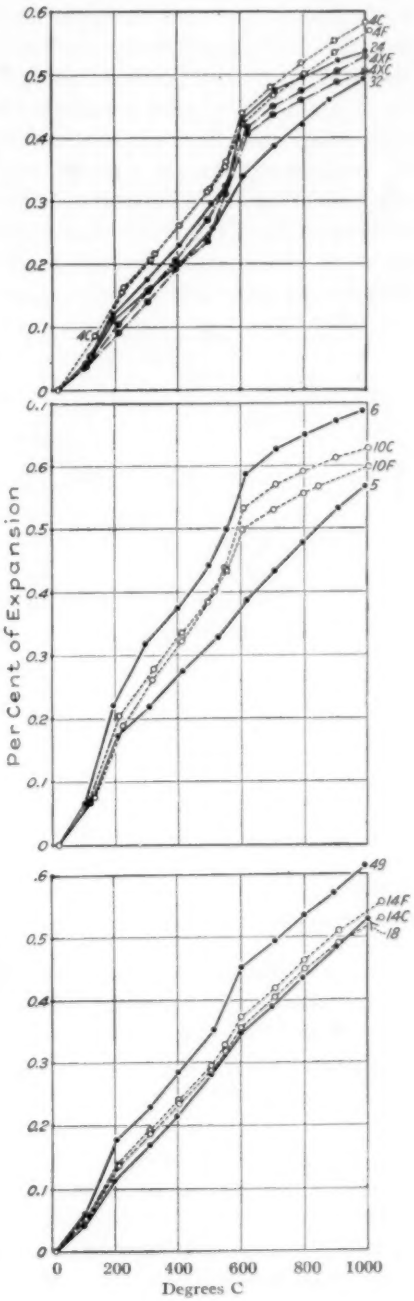

FIG. 1

(Legend to Fig. 1)

Thermal-expansion curves of representative clays and of bodies prepared from them. The curves illustrate the various changes which may occur in the thermal expansion when clays are blended.

made from it produces no effect on the thermal expansion of the blend fired at 1230°C. Although bodies 4XC and 4XF have an expansion similar to those grouped in Class 2, the expansion curves are shown at the top of Fig. 1 to facilitate comparison with the curves for Bodies 4C and 4F. Bodies 4XF and 4XC are identical in every respect with Bodies 4F and 4C, respectively, except that the grog used in the former had been fired to approximately 775°C instead of 1230°C. Due to the comparative softness of the grog fired at 775°C, it disintegrated somewhat during mixing with the clays and pugging of the body which caused a more intimate mixture of clays and grog than if the grog had been fired at a considerably higher temperature. This, together with the fact that the clay as grog had not altered as much in its physical properties when fired at 775°C as when fired at 1230°C, probably was the cause of a more complete reaction occurring between the constituents in the clay and grog, which resulted in an expansion approximately the average of the two individual clays.

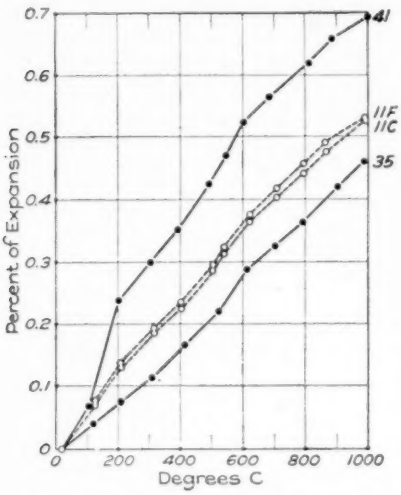

FIG. 2.—Showing widely different types of thermal expansion curves of two clays (full lines) and of the two bodies in which they were blended.

An example of the expansion of bodies grouped in Class 2 is shown in the center section of Fig. 1. The curves given were obtained on Bodies 10F and 10C which were prepared from Clays 5 and 6 and grog made from these clays. The expansion curves for the individual clays are also shown.

The curves in the lower portion of Fig. 1 show the expansion of Bodies 14F and 14C in Class 3. These bodies were made of Clays 18 and 49, and grog from the same clays fired at 1230°C. The thermal-expansion curves for the individual clays, also given, show a large difference in total expansion. Since the expansions of the bodies closely approach the lower and more desirable expansion of Clay 18, it would indicate that the selection of clays as far as this property is concerned was favorably made. Apparently most clays blended as in this study act favorably with respect to the thermal expansion since the majority of bodies are classed in this group.

Table I shows that all bodies except Nos. 11F and 11C were prepared from clays having the same general type of expansion, that is, both were classed in either Group H or L. Bodies 11F and 11C were prepared with

Clay 35 from Group H (uniform and relatively low rate of expansion below 200°C) and Clay 41 from Group L (irregular and relatively higher rate of expansion below 200°C). Figure 2 shows the expansion curves for Bodies 11F and 11C as well as those of Clays 35 and 41. The expansion curves of the bodies illustrate what may be accomplished by blending two clays having a very large difference in total expansion as well as entirely different rates of expansion below 200°C. The P.C.E. values of Clays 35 and 41 are 20 to 26 and 30 to 31, respectively. Any reaction occurring between these clays during firing was undoubtedly facilitated by the comparatively low P.C.E. value of Clay 35. The combination of these two clays was decidedly advantageous in eliminating the high and unfavorable rate of expansion of Clay 41 below 200°C.

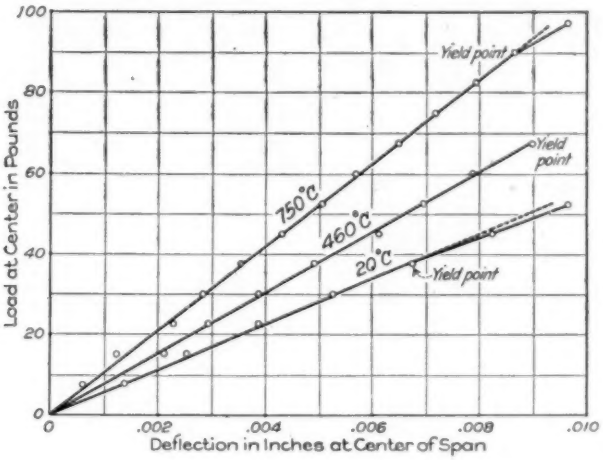

FIG. 3.—Curves showing the typical stress (load) strain (deformation) relation of a sagger body tested at three temperatures.

A comparison of the thermal-expansion curves of the bodies containing the coarser grog with those prepared with the finer grog shows that the expansion of the coarse-grogged bodies is slightly lower than the fine-grogged bodies in 67% of those tested; approximately the same in 20% and higher in 13%.

A comparison of the thermal expansion curves of the sagger bodies with those of the two clays composing each of the bodies shows that out of the total of 15 combinations, 12 were advantageously made with respect to the thermal expansion of either one or both clays.

Check determinations of expansions were made on eight specimens of sagger bodies. The greatest variation in the data obtained on the same body was less than $\pm 2^1/_2$ per cent.

(4) Modulus of Elasticity and Transverse Strength The deflections corresponding to various loads applied to Body 20SF are plotted in Fig. 3. Results obtained at 20°C, 460°C (the temperature at which the sagger failed in the heat shock test), and 750°C are plotted to illustrate the increase in resistance to bending of sagger bodies as the temperature within these limits is increased.

Bodies Fired at 1230°C The modulus of elasticity and transverse breaking strength (modulus of rupture) of 37 bodies, including eight containing the grog fired at 775°C and one containing grog and dust passing through a No. 80 sieve, were determined at

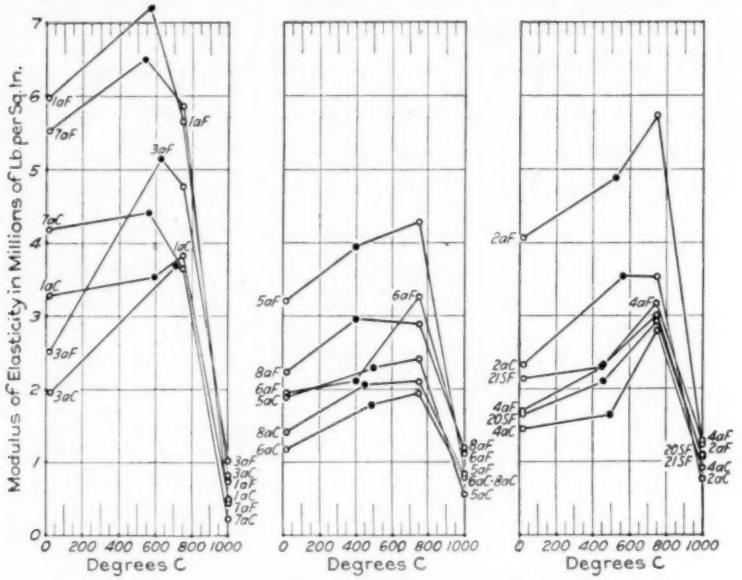

FIG. 4.—The effect of temperature on the modulus of elasticity of eighteen sagger bodies. Filled circles indicate temperatures at which saggers failed in the air-quenching test.

room temperature, at the temperature of failure in an air-quenching test of saggers made from these bodies and also at 750°C. The values obtained on 1 x 1 x 12-inch specimens, using a 10-inch span are given in Table II.

Bodies fired at 1270°C The modulus of elasticity and transverse breaking strength of 18 bodies including two containing special graded grog sizes, and in addition eight commercial bodies fired at 1270°C are given in Table III. These bodies were tested at 1000°C in addition to the three temperatures specified for bodies fired at 1230°C. The composition and order of arrangement of the first 16 bodies in Table II are identical with the first 16 bodies in Table III.

The results indicate that there is a slight tendency for the bodies to show increased transverse breaking strength with increased temperatures to 1000°C, the maximum temperature used in these tests. The same holds true regarding the modulus of elasticity up to 750°C. At 1000°C the latter property shows a decided decrease. The percentage increase in the modulus of elasticity attending an increase in temperature from 20 to 750°C is greater than the corresponding increase in cross-breaking strength. Figure 4 shows the effect of temperature on the modulus of elasticity of bodies fired at 1270°C. The curves are presented in three sections to facilitate examination.

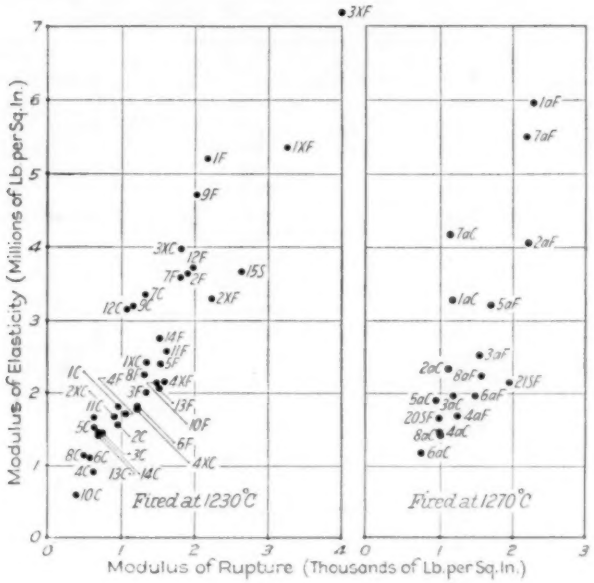

FIG. 5.—Showing the relation between modulus of elasticity and transverse strength (modulus of rupture) determined at room temperature of sagger bodies fired at either 1230 or 1270°C.

Values for the modulus of rupture determined at approximately 20°C for bodies fired at 1230°C and 1270°C and plotted as in Fig. 5 indicate that the ordinary or usual relation exists between transverse strength and modulus of elasticity, that is, the modulus of elasticity is greatest with the greatest strength. These figures also show that the modulus of elasticity increased more rapidly than the modulus of rupture as the temperature of firing was raised. As stated in the Third Progress Report,[12] the relationship is

[12] See footnote 4.

only approximate and the explanation for the variations is not evident from the data at hand.

The Third Progress Report of this investigation states that check determinations of moduli of elasticity and rupture were made at room temperature on all clay specimens and check determinations were made of three clay specimens at higher temperature. The results varied less than 10%. Check determinations of these same properties were made on 25 specimens referred to in the present report and the values obtained are given in Table V together with the original value. The results in

TABLE V

DETERMINATIONS AND CHECKS OF MODULI OF ELASTICITY AND RUPTURE OBTAINED ON SAGGER BODIES AT SEVERAL TEMPERATURES

Body no.	Modulus of elasticity 1000 lbs./sq. in.	Modulus of rupture lbs./sq. in.	Results obtained at
4XC	1730	1210	Room temperature
	1740	1215	
8C	1000	510	Room temperature
	1110	500	
10C	520	450	Room temperature
	565	395	
11C	1340	660	Room temperature
	1625	600	
3F	3920	1770	
	3500	1940	
5F	3520	1970	
	3560	1920	
6C	1960	950	Temperature at which sagger failed in heat shock test
	1960	920	
7C	3050	1185	
	3330	1355	
9C	4400	1200	
	4285	1340	
9F	5920	(a)	750°C
	6020	2320	
13F	3100	(a)	750°C
	3100	2320	
6aC	1180	765	Room temperature
	1200	760	
6aC	785	1550	1000°C
	700	1420	

(a) No data obtained.

the majority of these cases also varied less than 10%. The test piece was considered defective if the rupture occurred at a point other than at approximately the middle of the 10-inch span. In such cases the necessary data were determined on a second specimen. As has been stated, those specimens of each body tested at three temperatures not greater than 750°C, exclusive of the test at 1000°C, were found to have decreased in flexibility as the temperature was raised at which the tests were made. If the load-deflection curves for these specimens became more nearly vertical with each increase of temperature (thus indicating a decrease in

flexibility), this fact was considered as further evidence of the specimens being free from important defects.

(5) Plastic Flow Typical load deflection curves, as obtained at 1000°C for Body 20SF are shown in Fig. 6. The upper curve shows the plastic flow of the material under various loads, the center curve shows the elastic properties, and the lower curve shows the total deflection of the specimen at each of the loads indicated. As stated in the Fourth Progress Report,[13] the elastic recovery of the material was considered as the difference between the deflection caused by the load and the "set" of the material on removal of this load. The deflections resulting from plastic flow of 24 sagger bodies fired at 1270°C are given

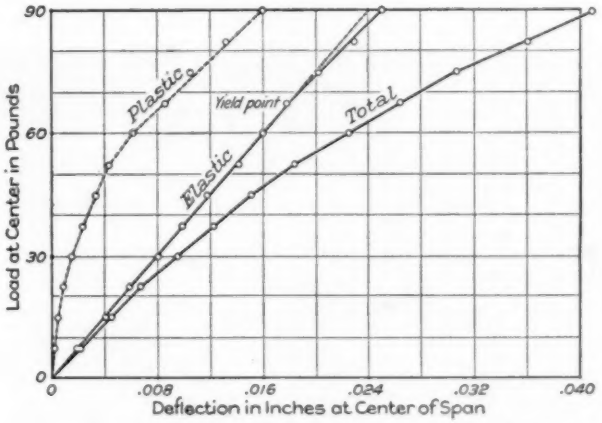

FIG. 6.—Showing the load-deflection curves of body 20 SF at 1000°C. The upper curve shows the plastic flow or set of the material, the middle curve the elastic deflection and the lower curve the total deflection at each of the loads indicated.

in Columns 1 and 2, Table VI. The results were obtained at 1000°C and they are the average of increments obtained every 5 minutes for one-half hour when using a load of 30 lbs./sq. in., and for one hour when using a load of approximately 120 lbs./sq. in. The load was applied midspan of the 1 x 1 x 12-inch specimens on a 10-inch span. The values given in Column 3, Table VI, represent the total plastic deflection, in inches, of the various bodies under a stress of approximately 240 lbs./sq. in. The values, taken from curves similar to that identified as "plastic" in Fig. 6, illustrate the large variation in this property among the various bodies. It is quite possible that an appreciable error may be present in the results obtained with a load of 30 lbs./sq. in. because of the limit of accuracy of the apparatus used.

[13] See footnote 5.

For convenience the porosities of the bodies fired at 1270°C are shown in Column 4, Table VI, with the plastic flow data. These values plotted in Fig. 7 indicate that, as illustrated by one of a number of lines which

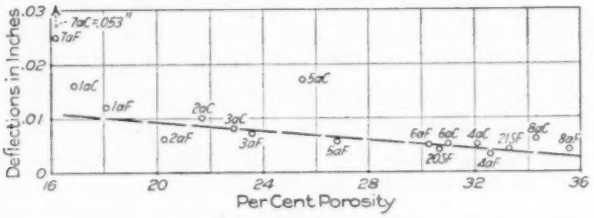

FIG. 7.—The effect of porosity on the plastic flow of sagger bodies.

may be drawn through the plotted points, there may be a tendency for the plastic flow (Column 3) of the body to decrease as the porosity of the body becomes greater when determined under the conditions stated.[14]

TABLE VI
PLASTIC FLOW DATA DETERMINED ON SAGGER BODIES FIRED AT 1270°C

Body No.	Average of deflection readings, in inches, taken at 5-minute intervals, on a 1x1x12-inch specimen, using a 10-inch span and temperature of 1000°C: During ½ hour using stress approximately 30 lbs./sq. in.	Average of deflection readings, in inches, taken at 5-minute intervals, on a 1x1x12-inch specimen, using a 10-inch span and temperature of 1000°C: During 1 hour using stress approximately 120 lbs./sq. in.	Total plastic deflection, in inches, (taken from plastic flow curves) at 1000°C with a stress approximately 240 lbs./sq. in.	Porosity (%)
	(1)	(2)	(3)	(4)
1aF	0.0002	0.0002	0.012	18.1
1aC	0.0002	0.0003	0.016	16.9
2aF	<0.0001	<0.0001	0.006	20.3
2aC	<0.0001	0.0001	0.010	21.7
3aF	<0.0001	<0.0001	0.007	23.6
3aC	<0.0001	0.0001	0.008	22.9
4aF	<0.0001	<0.0001	0.003	32.6
4aC	<0.0001	<0.0001	0.005	32.1
5aF	0.0001	0.0002	0.017	26.9
5aC	0.0002	0.0003	0.017	25.5
6aF	0.0001	0.0001	0.005	30.3
6aC	0.0001	0.0001	0.005	31.0
7aF	0.0002	0.0004	0.025	16.2
7aC	0.0002	0.0007	0.053	16.2
8aF	<0.0001	<0.0001	0.004	35.6
8aC	0.0001	0.0001	0.006	34.3
20SF	<0.0001	<0.0001	0.004	30.7
21SF	<0.0001	0.0001	0.004	33.3
A	0.0001	0.0001	0.012	26.3
B	0.0001	0.0001	0.004	27.1
E	0.0001	0.0001	0.011	29.9
F	0.0001	0.0001	0.018	29.3
G	0.0001	0.0001	0.016	29.9
H	0.0001	0.0002	0.011	26.6

[14] This relationship would possibly become more exact if deflection determinations had been made on several specimens instead of only one, as in the present study. The porosity given is the average of five determinations.

Such a relation might be expected since the fluxes introduced by the clays in a dense sagger body have a greater opportunity for reaction during firing than if present in a less dense body.

Bodies 7aF and 7aC, although showing good resistance in the heat-shock test, would undoubtedly prove unsatisfactory for sagger purposes because of a comparatively high plastic flow at 1000°C.

(6) Air Quenching or Dunting Tests

The results, showing the average temperature of failure of five small oval saggers in the heat-shock test, are given in Table II for the saggers fired at 1230°C and in Table III for the saggers fired at 1270°C. Table III also contains the results of the tests on saggers prepared from commercial sagger bodies furnished by several potteries.

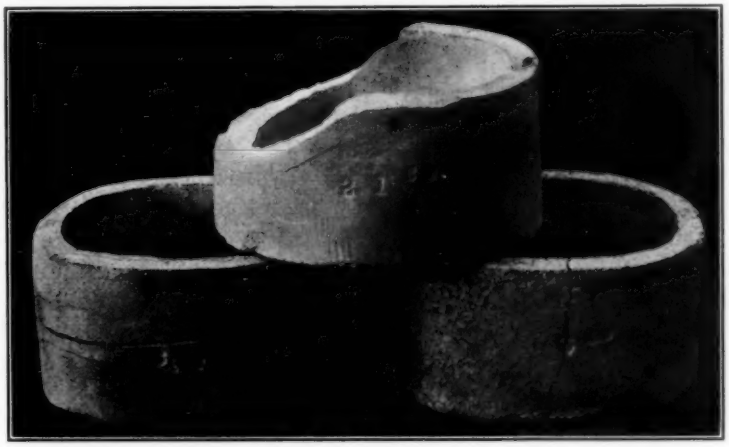

FIG. 8.—Saggers illustrating the three different types of failures which occurred in the thermal shock test.

The types of failure encountered during the testing of these saggers are shown in Fig. 8. Sagger 1 illustrates a failure found only in saggers prepared from bodies containing the fine grog sizes. Sagger 2 shows the type of failure which was the most prevalent. The third type of failure, illustrated by Sagger 3, occurred only in a few cases.

The average, the maximum, and the minimum temperature of failure and porosities of the saggers prepared from the first 16 bodies, listed in Tables II and III, are given on the following page.

These average values show that the coarse-grogged saggers resist thermal shock to a considerably greater extent than the fine-grogged saggers, although this difference is more pronounced in the saggers fired at 1230°C than those fired at 1270°C. These results also show that the resistance

SAGGERS FIRED

Temperature of failure	At 1230°C		At 1270°C	
	Fine grog	Coarse grog	Fine grog	Coarse grog
Maximum	760°C	860°C	400°C	450°C
Minimum	445	500	630	710
Average	580°C	675°C	495°C	540°C
Porosity (per cent)	26.2	26.2	25.4	25.1

to thermal shock decreases noticeably with the increased temperature of firing of saggers. Furthermore, a comparison of the average porosities of the fine- and coarse-grogged bodies indicates that within the ranges of grog sizes and temperatures of firing studied, the porosity as determined does not give a true indication of the pore structure of the body.

Sagger Bodies 9F, 9C, 10F, 10C, 12F, 12C, 13F, and 13C were prepared from two clays each and grog made from only one of the clays used in the respective bodies. The grog used in Sagger Mixes 9F, 9C, 12C, and 12F was prepared from that clay in the mix having the lower porosity after firing at 1230°C, whereas Bodies 10F, 10C, 13F, and 13C contained grog prepared from that clay in the body having the higher porosity after firing at 1230°C. Furthermore, Bodies 7F and 7C contain the same clays as Bodies 9F and 9C and Bodies 13F and 13C contain the same clays as 14F and 14C. The results obtained in the thermal shock test indicate that saggers prepared with grog having a relatively high porosity show greater resistance to heat shock than do saggers containing grog having a low porosity. A summary of the average values obtained on the fine- and coarse-grogged bodies as well as those of the clays are as follows:

AVERAGE TEMPERATURE OF FAILURE OF SAGGERS

Body numbers	Type of grog in body	Prepared from: Single clays (°C)	Prepared from: Blended clays (°C)	Remarks
7F and 7C	Equal parts high and low porosity	665	650	Same clays in Bodies 7 and 9
9F and 9C	Low porosity	665	605	
10F and 10C	High porosity	390	520	
12F and 12C	Low porosity	570	575	
13F and 13C	High porosity	435	655	Same clays in Bodies 13 and 14
14F and 14C	Equal parts high and low porosity	435	575	

Bodies 10 and 12, although compounded with different clays, illustrate the effect on the resistance to thermal shock of saggers containing either dense or porous grog. As shown, the average of the two failing temperatures of the saggers made from each clay used in Body 10 was 390°C; the saggers from the blended clays and a porous grog showed greatly increased resistance to failure. The temperature of failure in this case was 520°C. In the case of Body 12, the average of the two failing temperatures of the saggers prepared from each clay was 570°C, whereas the average of the failing temperatures of saggers prepared from the blended clays

and a dense grog was 575°C. Furthermore, a comparison of the results obtained on Body 7 with Body 9 and also on Body 13 with Body 14 indicates that the sagger containing the greater percentage of porous grog shows the greatest resistance to heat shock.

Bodies 11F and 11C are described in the section on "Linear Thermal Expansion." The average of the two failing temperatures of the saggers made from each of the constituent clays was 465°C, the average of the two failing temperatures of saggers prepared from the blended clays was 645°C. The reaction which occurred, incident to the firing of these two blended clays, caused an unusual improvement in the thermal expansion of the blended clay sagger bodies (see Fig. 2) and undoubtedly was partially the cause of the excellent resistance to failure shown by the saggers in the heat shock test.

Bodies 1XF to 4XC inclusive, representing the eight sagger mixes compounded with grog materials fired at 775°C, contain clays of the same laboratory key numbers as Bodies 5, 6, 7, and 4, respectively. As indicated by the results in Table II, this method of preparing grog does not improve the resistance of saggers to thermal shock. The grog is sufficiently soft to permit its disintegration during pugging of the sagger body which in consequence causes a body of finer texture with increased modulus of elasticity. At the same time the heat conductivity of the sagger is probably decreased, which also would be a factor in decreasing the resistance to failure in the heat shock test.

Body 15S, which contains the grog and dust passing an 80-mesh sieve, was included to show the effect of extremely fine grog on the resistance to failure of a sagger in the thermal shock test. Both the porosity and transverse strength of this body are high, and the saggers failed at or below 350°C, an exceptionally low temperature. Body 8F containing the same body composition but with graded grog failed at 450°C.

Body 21SF (Table III) was prepared from the same clays as Bodies 4aF and 4aC, but the grading of the grog was varied as shown in the section on "Sagger Body Compositions." Although Body 21SF contained 40% of grog passing an 80- and retained on a 200-mesh sieve, the sagger failed in the air-quenching test at approximately the same temperature as Body 4aF, which contained no grog finer than that retained on an 80-mesh sieve. This would indicate that properly graded grog sizes even as fine as those used in Body 21SF may be used to advantage to increase the mechanical strength of saggers.

Body 20SF was prepared from the same clays as Bodies 6aF and 6aC but with a fairly wide range of specially graded grog sizes. The saggers made from Body 20SF failed at 460°C in the heat-shock test, the approximate average failing temperature of saggers made from bodies 6aF and 6aC which failed at 400°C and 590°C, respectively. The modulus of

elasticity and transverse strength of Body 20SF determined at 20°C is also approximately the average of that obtained on Bodies 6aF and 6aC. According to the data given in Table VI, the plastic flow of Body 20SF under a load of 240 lbs./sq. in. is slightly less than that of either Body 6aF or 6aC. It would, therefore, appear from the limited data available that the use of grog, graded into as many as six sizes, is of no outstanding advantage in a sagger body when compared with bodies using three sizes of graded grog.

The data show that the individual saggers in any one set of five fired at 1230°C failed in the quenching test within 100°C, or less, of one another in 32 out of a total of 37 bodies, and those fired at 1270°C failed within 75°C, or less, of one another in 23 out of a total of 26 bodies.

(7) Relation between Porosity and Dunting As indicated by the following table of averages of the temperatures at which saggers failed in the air-quenching test and the porosities of the fired sagger bodies, it is advantageous to keep the porosities of these bodies below 25%. The bodies were separated into two groups, according to whether the porosity was greater or less than 25%.

Saggers fired at (°C)	Average temperature of failure (°C)	Porosity (%)
1230	675	20.7
	565	31.2
1270	590	19.5
	455	31.2

Sufficient data are not at hand to warrant any conclusions as to the lowest permissible porosity compatible with the longest sagger life.

(8) Effect of Thermal Expansion on Dunting Grouping the sagger bodies fired at 1230°C into two classes according to whether saggers prepared from them failed at temperatures above or below 600°C and averaging the temperatures at which they failed as well as the coefficients of expansion of each group from 20 to 250°C, gives the following:

Group	Average failing temperature (°C)	Average coefficient of expansion ($\times 10^{-6}$)
I	695	6.1
II	525	8.2

(9) Modulus of Elasticity, Expansion, Transverse Strength, Porosity, and Resistance to Dunting An empirical relation, combining the three factors, (1) modulus of the elasticity, (2) linear thermal expansion, and (3) transverse strength, which was suggested as indicating the relative resistance to failure due to thermal shock was given in the Third Progress Report.[15] The sagger

[15] See footnote 4.

bodies referred to in that report contained grog which had been graded alike for all mixtures. Substituting the data obtained in the present work in that formula, it was found that the factors R so computed did not satisfactorily indicate the relative resistance to thermal shock actually obtained. Changing the formula to include the porosity of the body overcame this discrepancy. This may result from the fact that the thermal conductivity of the body may have a significant effect on its resistance to heat shock. Since it is reasonable to assume that pores affect conductivity, porosity might be introduced into the formula and more consistent values of R obtained. Consequently the formula is altered as follows:

$$R = \frac{M}{EeP}$$

where R = factor indicating relative resistance of a sagger to failure
M = modulus of rupture
E = modulus of elasticity
e = coefficient of linear thermal expansion
P = porosity

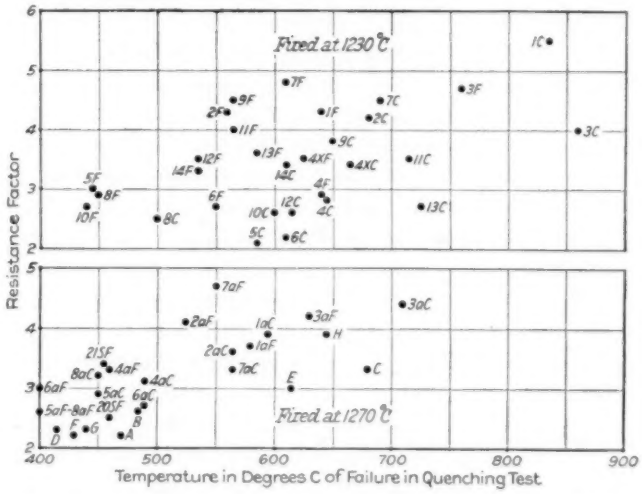

FIG. 9.—Showing resistance, R, of saggers, fired at either 1230 or 1270°C, to dunting. Data used in computing the resistance factor were determined at 20°C and the average coefficient of expansion was taken from 20°C to the temperature at which the saggers failed in the air-quenching test.

The resistance factors R, computed from the moduli of elasticity and rupture and porosity determined at 20°C and the average coefficient of expansion for the range from 20°C to the temperature at which the saggers failed in the heat-shock test, are given in Tables II and III for the saggers fired at 1230 and 1270°C, respectively. R, plotted against the failing temperature of the saggers in Fig. 9, shows that the greater the numerical

value of this factor the greater the resistance of the sagger body to heat shock. Values for R computed from the moduli of elasticity and rupture determined at either 750°C or the failing temperatures of the saggers in the heat-shock tests and the average coefficient of expansion between 20 and 600°C give a similar relation. Although the relation between the calculated resistance R and the life of the sagger as indicated by the quenching test is not as close as may be desired, the trend of the points in Fig. 9 indicates such a relation. The irregularities in the trend of the points may be partially accounted for by the differences in fired properties resulting from unavoidable variations in the heat treatment which the saggers and specimen bars received. This difference in heat treatment was especially apparent in the case of the material fired at 1230°C, the resistance factors for which show the greater irregularity. In addition, other properties, such as thermal conductivity and modulus of elasticity in shear, which have not been determined in these studies, undoubtedly have an appreciable effect on the resistance of saggers to failure in the thermal shock test.

The resistance factors for the majority of the bodies fired at 1230°C are grouped near the approximate center of the upper graph in Fig. 9, whereas the bodies fired at 1270°C have grouped themselves to the bottom left of the lower graph. This illustrates that the firing at the higher temperature has a detrimental effect on the resistance of the sagger to heat shock. Since repeated firings at the same temperature appear to have similar effects on the properties of sagger bodies[16] as firing at higher temperatures, it would appear that the resistance of a sagger to heat shock is decreased after each heating cycle in service. In the lower graph the factor for Body 7aF is an exception to the general trend for bodies in that group. The factor indicates a relatively high resistance while the temperature at which the saggers failed is comparatively low.

(10) Extreme Fiber Deformation The maximum deformation of the extreme fiber[17] is the deformation under the maximum stress at midspan along the upper and lower surfaces of the specimen. The outer fiber deformation values of the fired sagger bodies at various temperatures given in Tables II and III (columns headed "Computed Outer Fiber Strain") are all computed by the following formula:

$$\left.\begin{array}{r}\text{Maximum elongation per}\\ \text{unit length, per cent}\end{array}\right\} = \frac{\text{modulus of rupture}}{\text{modulus of elasticity}} \times 100$$

[16] Data on the effect of repeated firing of sagger clays are published in the First Progress Report (see footnote 2).

[17] A detailed discussion on maximum deformation (elongation) and why it is desirable to use the secant modulus of elasticity when computing the strain values at 1000°C may be found in the Fourth Progress Report of this investigation, *loc. cit.*

The values so obtained are an expression of the approximate flexibility of the materials. An examination of these data indicates that the flexibility of the bodies decreased (1) with increased temperature of firing and, (2) as the temperature of the material is raised until plastic flow commences under the load applied.

(11) Commercial Sagger Bodies The laboratory identification letters for the commercial sagger mixes are A to H inclusive. The properties of the bodies as determined on specimen bars and experimental saggers fired at 1270°C (cones $11^1/_2$ to 12) are given in Table III. The resistance factors R of these mixes, given in Table III, are included with the others plotted in Fig. 9. The resistance to failure in the thermal-shock test of saggers, prepared from Bodies C, E, and H, is noticeably greater than that of the saggers prepared from the other five bodies. The modulus of elasticity of each of these three bodies is less and the computed outer fiber strain is greater than those of the remaining bodies. The increased resistance to failure of the saggers made from these bodies is probably due to these favorable factors. The properties of these bodies appear as a whole to be similar to the properties of the coarse grogged experimental bodies prepared in the laboratory. Largely because of the coarse sizes of grog used in the bodies, the fired strength and the modulus of elasticity are low. It is believed that a low modulus of elasticity is desirable in a sagger body.

Bodies C and D were furnished by the same manufacturer. Body C developed after a study of experimental sagger bodies, shows a great improvement in resistance to thermal shock when compared with Body D. The modulus of elasticity of Body D is approximately twice that of Body C and is probably one of the most significant properties affecting dunting of saggers in the heat shock test at comparatively low temperatures. These data are of especial interest since they demonstrate that increased life of saggers, due to their greater resistance to thermal shock, may be obtained by altering the sagger mixes in such a manner as to produce a structure of the fired ware having those properties effective in prolonging the life.

VI. Summary

Five small saggers were made from each of 23 experimental bodies and 10 small saggers were made from each of 16 bodies. The 39 bodies were prepared from 15 different clays and grogs made from these clays. The majority of the bodies were made of two clays and grogs prepared from these clays, each combination of clays being made into two bodies, one prepared with coarse graded grog and the other with comparatively fine graded grog. The saggers were tested for resistance to heat shock after firing at either 1230 or 1270°C. Specimen bars were made to correspond

with each set of saggers and fired simultaneously with the saggers. These bars were used for determining the linear thermal expansion from 20 to 1000°C, porosity, moduli of elasticity, and rupture at room and elevated temperatures, and plastic flow at 1000°C. In addition, saggers and specimens from eight raw sagger bodies furnished by potteries were fired at 1270°C and tested.

The linear thermal expansion of the bodies fired at 1230°C shows that they may be classed as follows into three groups according to the expansion: that of the body may be (1) greater than that of either clay, (2) approximately equal to the average of that of the clays, (3) approximately equal to that clay having the lower expansion. A comparison of the expansion of the bodies prepared with the coarse sizes of grog and those prepared with the finer sizes of grog shows that in the majority of cases the coarse grogged bodies have the lower expansion. A comparison of the thermal expansion of the sagger bodies with those of the clays contained in the bodies shows that of the total of 15 combinations, 12 had more desirable expansions than either one or both of the constituent clays.

A direct relation between modulus of elasticity and transverse strength of the bodies is shown. The modulus of elasticity increased more rapidly than the strength when the bodies were (*a*) fired at 1270°C as compared with 1230°C, and (*b*) tested at increasing temperatures ranging from 20 to 750°C.

A relation between porosity and plastic flow of the bodies under load at 1000°C is indicated.

The results show that the resistance of saggers to thermal shock (1) decreases with increased temperature of firing of saggers, (2) is generally less for bodies having a porosity greater than 25% when compared with those having a porosity less than 25%, (3) is greater for saggers prepared with grog having a relatively high porosity than those containing grog of low porosity, and (4) is greater for bodies having a comparatively small and uniform rate of expansion below 250°C.

A study of the data indicates that the best sagger bodies found in this preliminary experimental study are those having the following properties: (1) low modulus of elasticity, (2) high transverse strength, (3) porosity below 25%, and (4) low and preferably uniform thermal expansion from 20 to 250°C. In addition, it was found that clays of low refractoriness may sparingly and advantageously be used to increase sagger life and that properties stated as (1) and (2) may be partially controlled by grading of grog sizes.

The modulus of elasticity, transverse strength, porosity and coefficient of expansion may be combined into an empirical formula which will give indications of the probable life of a sagger when subjected to repeated thermal shock.

PRESENT PRACTICE IN WHITEWARE PERIODIC KILN DESIGN[1]

By R. G. Mills[2]

ABSTRACT

Tables of whiteware kiln dimensions and design ratios are presented. Distribution charts are included which show the present tendency in kiln size and kiln design factors. Attention is called to the wide variations found in some of the design factors and to the rather narrow limits within which others fall.

Introduction

This paper deals with round periodic kilns for firing sanitary ware, electrical porcelain, and floor and wall tile. All the kilns listed are of the open fire sagger type with the exception of the two muffle kilns noted.

Source of Data All of the data presented were made available to the author through the courtesy of the New Jersey Clayworkers' Association and obtained by means of the kiln survey recently made by the Association.[3] Each kiln reported in the survey represented an average of five other kilns in the same plant, similar in design and construction. Thus the figures given for the 39 kilns in the following tables represent actual conditions existing at the present time in approximately 234 kilns.

General Data

Table I contains the more general data for each kiln. All of the kilns listed in Tables I, II, and III are round, periodic open-fire, sagger kilns with the exception of Kilns 6 and 11 which are round, periodic muffle kilns.

Draft Of the kilns firing sanitary ware, 8 are updraft, 4 are up- and downdraft, and only one is a downdraft kiln. Of the 4 up- and downdraft kilns, 2 are muffle kilns leaving only 3 open fire kilns using up- and downdraft. If we consider the data to represent conditions in 78 kilns this indicates a decided predominance of updraft kilns.

For electrical porcelain, 8 are downdraft, 6 updraft, and 3 up- and downdraft indicating successful operation with all types and no tendency toward any one type.

For tile, 8 of the 9 tile kilns listed are downdraft, the remaining one having up- and downdraft. This shows a decided tendency toward downdraft kilns in the tile industry.

Purpose This shows the type of ware within each plant for which the kiln is used (*i.e.*, bisque, glost, one-fire, etc.). It is interesting to note that 3 of the sanitary-ware kilns are used for bisque and glost-

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received March 14, 1929.

[2] Instructor, Dept. of Ceramics, Rutgers University, New Brunswick, N. J.

[3] *Ceram. Age*, **12** [4], 126 (1928).

TABLE I
GENERAL DATA
Sanitary Ware

Number	Draft*	Purpose†	Fuel‡	Cone temperature	Hours on fire	Ware weight (% total setting)	Density of setting (lbs. / cu. ft.)	Diameter (feet)	Floor to shoulder (feet)	Spring of crown (feet)	Gross floor area (sq. ft.)	Gross volume (cu. ft.)
1	U	B	C	10	55	31.7	17.48	17.0	18.0	5.0	227	4719
2	U	G	C	7	51	29.7	18.61	17.0	18.0	5.0	227	4719
3	D	E	C	10	50	49.5		18.5			269	
4	U	B	C	9	51	30.2	18.78	16.5	13.0	3.5	214	3179
5	U	T	C	9	48	30.9	15.91	18.0	17.9	4.0	254	5089
6	A	E	C	10	100	73.2	14.29	18.7	8.0	4.5	276	2874
7	U	T	C	9	72	44.2	12.40	18.5	17.4	4.6	269	5350
8	U	T	C	9	43	29.1	18.48	16.5	16.9	1.9	214	3824
9	U	B	C	10	50	21.6	14.41	18.5	16.8	4.3	269	5139
10	U	G	C	8	46	22.2	15.80	18.5	16.8	4.2	269	5122
11	A	E	C	11	100	21.8	29.10	23.0	11.0	5.0	415	5669
12	A	G	C	6		27.2	18.25	18.0	18.0	3.0	254	5222
13	A	B	C	10	50	28.9	14.32	18.0	18.0	3.0	254	5222
					Electrical Porcelain							
14	D	E	O	12	42			14.0	10.8	2.8	154	1890
15	U	E	C	11	60	14.8	62.20	16.7	14.3	2.4	219	3402
16	U	E	C	11	36	57.9	53.90	12.5	12.5	2.4	123	1692
17	A	E	C	11	43	26.5	36.20	12.5	12.5	3.0	123	1736
18	A	E	C	11	42	30.1	24.75	14.2	12.5	2.0	159	2151
19	U	E	C	11	29	49.5		12.5	12.0	2.0	123	1666
20	D	E	C	11	49	32.8	42.90	16.5	12.0	2.5	214	2843
21	U	E	C	11	49	32.8	37.25	12.5	12.0	2.5	123	1638
22	D	E	C	11	47	28.0	29.00	10.6	10.7	3.5	87	1108
23	U	E	C	12	34	28.2	35.80	12.0	12.0	3.0	113	1540
24	D	E	C	11	42	21.7	31.25	12.5	12.0	2.0	123	1603
25	U	E	C	10	50	13.3		17.6	12.2	3.0	240	3307
26	D	E	C	10	50	45.8	39.90	15.5	11.7	2.9	189	2507
27	D	E	C	9½	65	25.3	24.80	16.5	13.0	3.0	214	3117
28	A	E	C	9	18	36.7	22.90	8.7	7.0	1.8	60	477
29	D	E	C	11	34	25.4	28.40	12.5	12.0	2.5	123	1638
30	D	E	C	12	36	16.1	53.50	12.5	12.5	3.0	123	1736
					Tile (Floor and Wall)							
31	D	B	C	9	41	42.6	31.40	14.0	12.0	3.0	154	2093
32	D	G	O	01	15	26.2	22.30	14.0	12.0	3.0	154	2093
33	D	B	C	6	48	51.7	36.30	12.5	14.0	3.0	123	1920
34	D	B	C	9	72	45.4	44.20	16.5	12.0	3.7	214	2990
35	A	G	O	3	20	25.0	32.10	14.0	12.0	3.0	154	2093
36	D	E	C	12	72	39.5	50.90	14.5	12.0	2.5	165	2195
37	D	E	C	11	74	40.4	25.38	16.5	13.4	6.5	214	3707
38	D	B	C	10		50.6	32.95	12.5	11.5	3.0	123	1620
39	D	G	C	04		26.1	27.00	15.5	12.0	3.0	189	2559

* U = up, D = down, A = up and down. ‡ C = coal, O = oil.
† B = bisque, G = glost, E = one fire, T = bisque and glost.

ware in the same fire. This is a matter of facilitating production, however, and no claims are made for its thermal efficiency.

Fuel Only 3 of the 39 kilns use oil; the remaining ones are all coal-fired, proving that coal is still the basic fuel at least in the section of the country covered by the survey.

Cone Temperature These figures are presented to permit a comparison to be made on the basis of the temperature to which the ware is fired.

Hours on Fire Fairly uniform practice is shown within each industry listed for the total length of time the kilns are fired. Several outstanding discrepancies may be accounted for. Kilns 6 and 11 are large muffle kilns and increased firing time is to be expected for this type. Kiln 28 is a very small kiln firing a special product which is not a true electrical porcelain. The small firing time is in keeping with a kiln of this size.

Ware Weight in Per Cent Total Setting Although the weight of ware fired is not a design problem it was thought desirable to include it since the figures were available and since they offer a good indication of present practice in ware-kiln-furniture percentages. Only 4 of the kilns are reported as firing ware weighing more than 50% of the total setting weight. The average for all the kilns is about 30%. This means that two-thirds of the material in a kiln is refractory kiln furniture which is fired over and over again. Figure 1 is a distribution chart which shows how the weight of ware fired varies within the three industries. Only one kiln exceeds 60% and this is a muffle kiln, as shown, which does not permit direct comparison between the percentage for this kiln and the percentages for open-fire kilns. Quite a wide variation is found within each industry, and while some of this may be accounted for by inaccuracies in measurement, due to the wide variation in ware weights from one firing to another, a great deal is probably due to differences in setting methods. Obviously anything which can be done to raise the percentage of ware fired will increase production and tend to increase kiln efficiency.

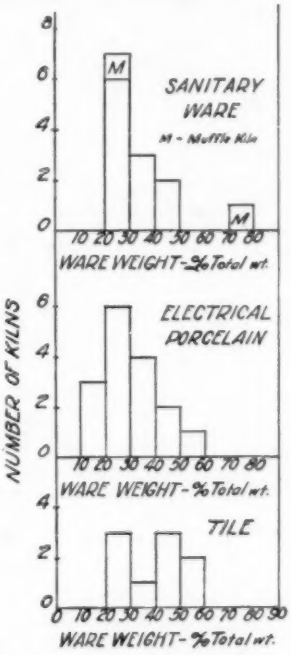

FIG. 1.—Distribution of ware weights.

Density of Setting This quantity is not a factor which enters into design, but it does indicate how closely maximum density of setting may be approached.

If an approximate figure of 1.85 is chosen as the average specific gravity of all the material contained in the setting then the maximum density attainable is 115 lbs. per cu. ft. This would, of course, mean a solid setting

with no air space in the kiln. Just how closely this maximum value is approached may be seen from the table. Figure 2 shows how this quantity varies within each of the three industries represented.

The sanitary-ware kilns show quite definitely a tendency toward a density of 15 to 20 lbs. per cu. ft. The average density is about 16 lbs. per cu. ft., this being the lowest average density of any of the industries shown. This is, of course, explained by the large and intricate shapes included in the setting.

The kilns firing electrical porcelain show a very wide range of setting densities. The largest number of kilns falling within any of the 5-pound increments are 5, which have a density of between 35 and 40 lbs. per cu. ft. The wide and scattered distribution may be caused by the great variation in sizes and shapes which are manufactured even in a single plant.

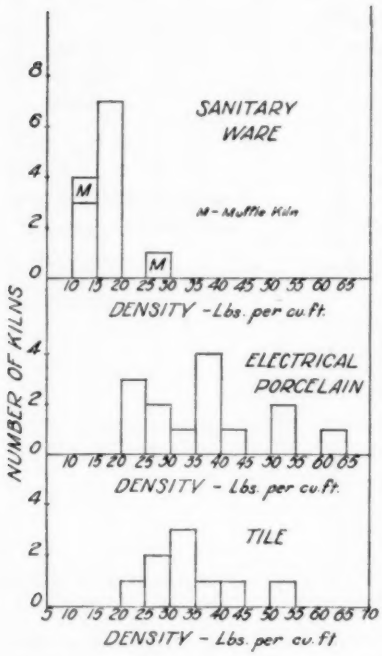
NUMBER OF KILNS
SANITARY WARE
M - Muffle Kiln
M
M
10 15 20 25 30 35 40 45 50 55 60 65
DENSITY - Lbs. per cu. ft.
ELECTRICAL PORCELAIN
10 15 20 25 30 35 40 45 50 55 60 65
DENSITY - Lbs. per cu. ft.
TILE
5 10 15 20 25 30 35 40 45 50 55 60 65 70
DENSITY - Lbs. per cu. ft.

FIG. 2.—Distribution of setting densities.

The tile kilns present a somewhat better appearance on the distribution chart. The chart shows a maximum between 30 and 35 lbs. per cu. ft. The average of these kilns is about 33 lbs. per cu. ft.

Diameter All diameters are inside measurements. The sanitary-ware kilns are all grouped rather closely with respect to their diameters. Figure 3 shows that only one kiln does not fall within the limits of 16 feet minimum and 20 feet maximum diameters.

For the electrical porcelain kilns the range of diameters is from 10 to 18 feet with one-half of the kilns falling between the limits of 12 and 14 feet. This is sufficiently representative to indicate that the present practice in electrical porcelain kilns is to use round kilns of 12 to 14 feet in diameter.

The diameters of the tile kilns as shown by Fig. 3 are between 12 and 18 feet. As may be seen from the chart, no particular diameter in this range is favored over the rest of them, and the kilns are quite evenly distributed. The average diameter of the kilns is about $14^1/_2$ feet.

Floor to Shoulder Height No great variations exist in the dimensions reported for the kilns except for Kilns 6, 11, and 28. Kilns 6 and 11 are muffle kilns as has been noted elsewhere

and Kiln 28 is very small. The general practice indicated is to make the floor to shoulder height either equal to or slightly less than the diameter.

Spring of Crown This dimension varies from about $1^1/_2$ to $6^1/_2$ feet for all the kilns reported. It is common practice to adjust this dimension to the diameter of the kiln so that it will permit a good solid crown to be constructed.

Gross Floor Area This is, of course, a function of the diameter and has been computed directly from it for each kiln. It is included here, because it is used as a basis for calculating design factors.

Gross Volume This quantity depends on the diameter and the height of the kiln considered. The average gross volume for the sanitary-ware kilns is 4700 cubic feet, for the electrical porcelain kilns 2000 cubic feet, and for the tile kilns 2400 cubic feet.

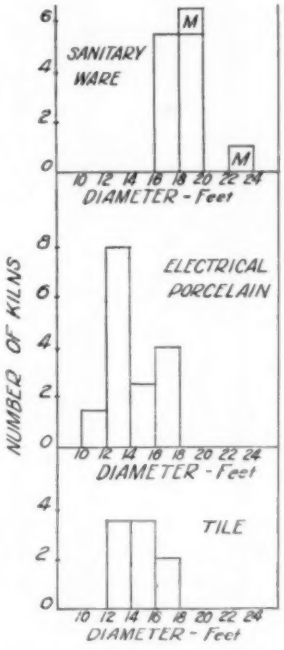

FIG. 3.—Distribution of kiln diameters (M = muffle kiln).

Flue and Grate Data

Table II contains the data concerning the flues and grates of the kilns listed. These data are for the most part self-explanatory. Only in a few instances is it possible to detect a common practice or a tendency toward one.

From the columns headed "Number of floor flues" and "Number of fire boxes" it is seen that for updraft and up- and downdraft kilns it is a quite general practice to have three times as many floor flues as fire boxes. This means for these two types of kilns that the common practice is to have three floor flues leading from each fire box toward the center of the kilns.

The table shows that except for one muffle kiln, all the sanitary-ware kilns have ten fire boxes. The number of fire boxes of course depends to some extent on the diameter of the kiln, and since the sanitary-ware kilns vary comparatively little in diameter it would be expected that the number of fire boxes would be about the same. Some slight variation, however, would ordinarily be found, unless some direct or indirect attempt at standardization has been made.

The electrical porcelain kilns show a much wider variation. Nine of the kilns use eight fire boxes, the remaining kilns use from four to ten.

The tile kilns like those firing sanitary ware show a decided tendency

TABLE II
FLUE AND GRATE DATA

Number	Number of floor flues	Cross-sectional area of one floor flue (sq. in.)	Number of floor openings	Area of one floor opening (sq. in.)	Number of wall flues	Area of one wall flue (sq. in.)	Bagwall height (inches)	Area of one throat (sq. in.)	Number of fire boxes	Area of one grate (sq. in.)
Sanitary Ware										
1	30	16	1	80			31	180	10	750
2	30	16	1	80			31	180	10	750
3	30	32	20	16	10	96	31	192	10	1248
4	30	48	1	113			24	216	10	1144
5	30	40	1	113			20	180	10	1080
6	20	90			20	72			10	648
7			1	113			36	162	10	840
8	30	36	1	113			36	144	10	1056
9	40	25	1	80			24	264	10	1150
10	40	25	1	80			24	264	10	1150
11					14	144			14	648
12	30	52	12	33	20	40.5	35	189	10	925
13	30	52	12	33	20	40.5	35	189	10	925
Electrical Porcelain										
14	8	48	24	12	8	48	30	288	8	
15	30	50	1	79			30	180	10	1104
16	24	36	1	50			18	120	8	1035
17	7	81	24	33			16	120	7	1050
18	24	48	32	16	16	81	22	288	8	1134
19	24	40	1	95			24	216	8	1104
20	10	96	20	36	10	81	43	180	10	820
21	24	36	1	133			26	140	8	1032
22	18	20	1	113			16	160	6	1008
23	24	24	1	113				130	8	1012
24									7	936
25	24	44	1	113			29	184	8	1144
26	9	81	20	36			43	220	10	920
27	10	91	10	40			43	160	10	920
28	4		8	112			23	108	4	966
29	39	47	1						8	1032
30	80	59	32	17					8	966
Tile (Floor and Wall)										
31	8	80	24	30	8	80	27	168	8	1008
32	8	80	24	30				168	8	
33	8	60	24	25	8	48			8	816
34	12	56	30	20			16	176	10	792
35	4	126	33	20			16	198	8	
36	9	63	4	20			24	147	8	1056
37	24		72						8	816
38	8	45	24	20					8	1150
39	8	45	24	20					8	1288

toward a definite number of fire boxes regardless of a variation of several feet in kiln diameter. All kilns listed use eight fire boxes with one exception.

Design Ratios

The commoner design ratios have been calculated where this has been possible, and these quantities are listed for each kiln in Table III. Some

of these quantities, as may be seen from the table, fall within rather narrow limits. This does not necessarily mean, however, that these quantities were determined and the kiln built accordingly. It is more probable that the quantities are fairly critical and the dimensions to satisfy them

TABLE III

DESIGN RATIOS

Number	Ratio of height to diameter	Kiln volume per fire box (cu. ft.)	Grate area in % gross volume	Grate area in % floor area	Throat area in % floor area
		Sanitary Ware			
1	1.35	472	1.10	23.0	5.75
2	1.35	472	1.10	23.0	5.75
3				32.2	5.27
4	1.00	318	2.50	37.1	7.36
5	1.22	509	4.72	29.5	5.22
6	0.67	287	1.57	16.3	
7	1.19	535	1.09	21.7	4.47
8	1.14	382	1.92	34.3	5.03
9	1.14	514	1.55	29.7	7.02
10	1.13	512	1.56	29.7	7.02
11	0.70	405	1.10	15.2	
12	1.17	522	1.23	25.3	5.16
13	1.17	522	1.23	25.3	5.16
		Electrical Porcelain			
14	0.97	236			11.19
15	1.00	340	2.25	35.0	5.95
16	1.19	212	3.40	46.7	5.71
17	1.24	248	2.94	41.5	5.06
18	1.02	269	2.93	39.6	10.41
19	1.12	208	3.69	49.9	10.30
20	0.88	284	2.00	26.6	5.83
21	1.16	205	3.50	46.7	7.14
22	1.34	185	3.79	48.3	8.55
23	1.25	193	3.65	49.7	7.08
24	1.12	229	2.84	37.0	
25	0.86	413	1.92	26.5	4.58
26	0.94	251	2.55	33.8	8.07
27	0.97	312	2.05	29.8	5.18
28	1.00	119	5.62	44.7	10.18
29	1.16	205	3.50	46.7	
30	1.24	217	3.09	43.7	
		Tile (Floor and Wall)			
31	1.12	262	3.69	49.9	6.06
32	1.07	262			6.06
33	1.36	240	2.36	36.9	
34	0.95	299	1.84	25.7	5.70
35	1.07	262			7.14
36	1.00	274	2.67	35.5	4.94
37	1.21	463	1.22	21.2	
38	1.16	202	3.94	52.0	
39	0.97	320	2.80	37.9	

have been determined by experience and "cut and try" methods on some of the earlier kilns. The newer kilns then have been built from the older specifications. If this same method has been used for determining dimensions from which some of the less critical quantities have been computed, then undoubtedly the efficiency of the kilns will vary even though

all of the kilns operate well enough to warrant their use. To illustrate, suppose two kilns of the same size and firing the same type and amount of ware are alike in all respects except that one has a grate area equal to 26% of the floor area and the other has a grate area equal to 50% of the floor area. One of these two kilns must be operating more efficiently than the other, although both may be producing ware which is satisfactory to the owner.

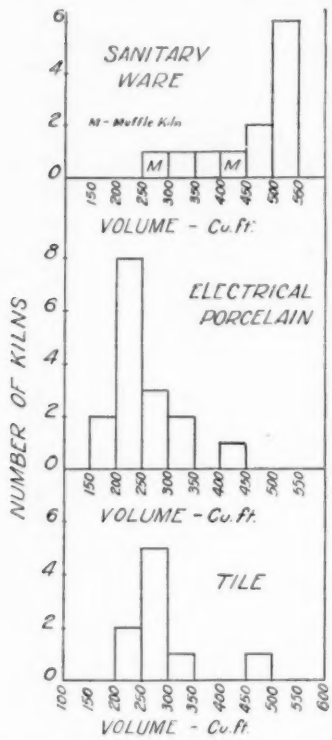
SANITARY WARE
M - Muffle Kiln
M
M
150 200 250 300 350 400 450 500 550
VOLUME - Cu. Ft.
ELECTRICAL PORCELAIN
150 200 250 300 350 400 450 500 550
VOLUME - Cu. Ft.
TILE
100 150 200 250 300 350 400 450 500 550 600
VOLUME - Cu. Ft.
NUMBER OF KILNS

FIG. 4.—Distribution of kiln volumes per fire box.

Table III, it is believed, does not indicate that it is common practice, at this time to make use of design ratios to any great extent. The close agreement of some of the values probably does not indicate a deliberate attempt to standardize on a particular value or set of values. The agreement, it is believed, is due to the critical nature of the ratios as has been mentioned elsewhere.

Ratio of Height to Diameter This quantity is not particularly important but it may be interesting to note the variations found. Including the muffle kilns the variation for all the kilns is from 0.86 to 1.36, the average ratio being about 1.06. The ratios were calculated from the inside diameters and the inside heights from floor to crown.

Kiln Volume per Fire Box All of the open-fire sanitary-ware kilns used ten fire boxes. Since the volumes of the kilns are not identical, however, the fire boxes are required to take care of different volumes. The volume per fire box which has been listed in Table III was obtained by dividing the gross volumes of each kiln by the number of fire boxes. Figure 4 shows a distribution chart for these volumes.

The sanitary-ware kilns show a decided tendency toward a volume per fire box of 500 to 550 cu. ft. half of the kilns, represented lying within these limits.

The electrical porcelain kilns show a tendency toward a volume of 200 to 250 cu. ft. per fire box.

The majority of the tile kilns use a slightly larger volume than the

electrical porcelain kilns, the tendency being toward a volume of 250 to 300 cu. ft. per fire box.

Grate Area in Per Cent Gross Volume[4] This factor which is probably fairly critical, in that any wide variations in it would not permit satisfactory operation, shows a very close agreement for most of the kilns within any one industry. The table shows that for the sanitary-ware kilns listed, the average is slightly less than 2%, for the electrical porcelain kilns it is about 3%, and for the tile kilns about 2.5%.

Grate Area in Per Cent Floor Area This quantity is similar to the one referred to in the preceding paragraph, except that the gross floor area is substituted for the gross volume.

Figure 5 shows the distribution chart of this quantity for the three industries. The sanitary-ware kilns show a fairly even distribution building to a maximum between 25 and 30%.

The electrical porcelain kilns show a very different type of distribution. The chart shows that the largest number of kilns use a grate area equal to the maximum range represented (*i.e.*, 45 to 50% of the floor area).

The tile kilns show a very wide distribution for the small number of kilns represented. Most of the kilns use a value of 35 to 40% which is also the average value.

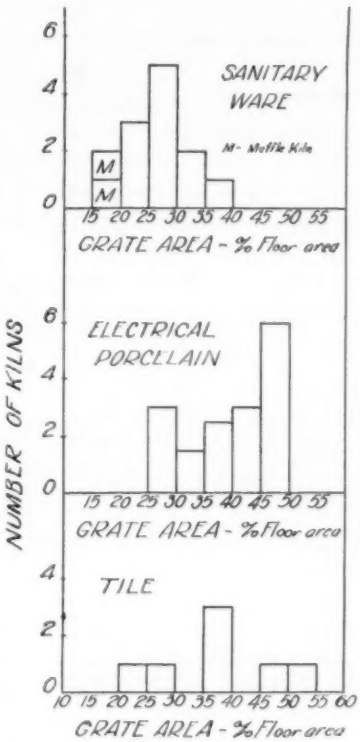

FIG. 5.—Distribution of grate areas.

Throat Area in Per Cent Floor Area[5] These values show a fairly close agreement for the sanitary-ware and tile kilns, but a very marked variation in the electrical porcelain kilns. This may be due in part to the fact that the types of draft are more varied in the electrical porcelain kilns than in either of the other two industries.

[4] The ratio of total grate area to gross volume × 100.

[5] The throat area is considered to be the total cross-sectional area of the spaces inclosed by each bag wall and the wall of the kiln, measured at the smallest cross-section, plus the area of the well hole in updraft kilns.

Summary

The data presented in the tables show very definite trends toward a common practice or standardization in some of the quantities involved in kiln design. There are indications, however, that the trends may be the result of duplications of particular features or dimensions rather than the result of an attempt at standardization of fundamentals of design in any one industry. It is believed that some of the design factors listed in the tables are sufficiently important to warrant an attempt to determine definite values or a set of values for a particular industry.

Acknowledgment The author wishes to thank G. H. Brown and A. E. R. Westman for their assistance in acquiring and compiling the data, and to express his appreciation for the courtesy shown by the New Jersey Clayworkers' Association in making the data available.

CAUSE AND CONTROL OF COLOR VARIATION IN CAST-IRON AND SHEET-IRON ENAMELS[1]

By W. F. Wenning

ABSTRACT

The need of uniformity and high quality in color chemicals for enamel ware becomes more important with the constant demand for colored enamel ware. The influence of opacifiers, enamel composition, and firing temperature on enamel colors is pointed out.

Introduction

The modern trend of color application in all classes of enamel ware, including kitchen utensils, stoves, ranges, sanitary ware, bathroom fixtures, restaurant fixtures, and other products to which colored enamels are applied makes it appropriate to call attention to some of the causes of color variation and how they may be avoided.

The color manufacturer is, of course, aware of the fact that his colors must be uniform and remain so during the preparation and firing process. They should be stable, inert, and chemically inactive with the glass composition. There are many limitations in the manufacture of colors just as the enameler is limited in compounding his enamel composition.

The Colors

Yellows are usually cadmium compounds. Some very good yellows are also derived from the various metal chromates. Other shades are compounded from antimony, uranium, titanium, and silver.

Reds are mostly cadmium-selenium compounds. There are also special types of chromates and prepared ferric oxides which have been used successfully in producing certain reds. Gold compositions also are used, but their cost is usually prohibitive.

Greens include practically every type of mineral oxide. Most of them, however, are compounded to include some chromium oxide in the form of some chromate or chromates combined with other mineral oxides and compounds.

Practically all ceramic blue colors are in some way compounded with cobalt oxide. There are, however, some colors which do not derive their bluish cast or tint to the presence of cobalt. This is usually caused by colloidal conditions of the color, or the enamel, or both.

Brown is composed chiefly of the base metal oxides such as manganese, iron, nickel, chromium, zinc, and also may include the oxides of aluminum, titanium, and zirconium.

Pink is either chromium-tin compounds or precipitated colloidal gold colors.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Enamel Division.)

Mahogany colors are usually cadmium-selenium and tellurium compounds. There are also specially prepared ferric oxides which have been successfully used in some types of enamel.

Grays are usually compounded from black bases diluted with white or light-firing mineral oxides as zirconium, aluminum, tin, titanium, and zinc.

Cases of Variation in Tint

It is obvious then that any change or variation in color may be attributed chiefly to the heat reaction between the various chemicals which compose the color and the chemicals which compose the enamels.

Cadmium yellows which are mostly sulphides, oxidize and fade during the firing operation. When the content of a sulphide yellow is above 2%, little variation occurs since there is a sufficient surplus of the sulphide to retain the color. It has been found, however, that less than 1% will cause considerable color variation. Light sections will fire out or fade away, whereas heavy sections of the ware will hold the color fairly well.

Other types of yellow are usually more stable and are recommended where light pastel shades are required. Chrome yellows, uranium, titanium, and antimony compounds show less variation when used in small percentages to form the pastel shades.

Greens, blues, and browns produce uniform shades if these colors are thoroughly stabilized in their manufacture so that their chemical reaction with the enamel composition is kept at a minimum.

Red and orange are more sensitive to heat reaction than most other colors. The variation is undoubtedly caused by the oxidation of the selenium or the chemical reaction of the selenium with the ingredients of the glass to form colorless selenite which accounts for the fact that red becomes lighter as the firing temperature is increased. Mahogany colors react in the same manner. The ferric oxide red and mahogany colors are fairly stable in the low temperature cast-iron enamels and have been used very successfully for this purpose. In steel enamels, however, these reds and mahogany colors combine with the enamel composition which results in many tones and often faded colors. Under repeated fires they lose their red or mahogany colors entirely producing a gray greenish enamel.

The chrome tin pinks are somewhat unstable in enamel compositions due to the reaction of the alkalis, which tend to fade the pink color. It is always recommended that 1 or 2% of tin oxide be added to this type of pink color which prevents or protects it from reacting with the enamel composition. The precipitated gold colors are more stable and are recommended for certain types of enamels where these shades may be applied.

Effect of Enamel Composition Another factor causing color variation is the composition of the enamel since we know that various compositions will produce different shades although using the same coloring oxide. The composition should be kept uniform and the enamels fritted or smelted uniformly. Certain types of enamels may be said to be either high or low in kryolith, soda, zinc, borax, or any of the other enamel-forming ingredients. The high or low in any one of these compounds has a decided effect on the final color of the enamel, *e.g.*, high sodas seem to intensify red, thus producing deeper shades than enamels which are low in soda and high in fluorides. In cast-iron enamels a high lead content seems to brighten certain types of yellows and greens. Zinc oxide causes greens to become dull and yet intensifies the cobalt colors. The enameler, therefore, who is changing his enamel composition in order to produce better enamels may expect to have color variation which may be attributed to the change in composition of his frit.

Influence of Opacifiers In most pastel shades some opacifying agent is used in conjunction with the color. The more common ones include tin oxide, zirconium oxide, and antimony compounds. If one is producing a certain shade of green, ivory, blue, tan, or gray which he has developed with the addition of one of the above opacifiers a decided change or a different shade will result by replacing the opacifier which he has used with another one; this is also true of clays. Different clays impart different physical properties to the final color and the kind of clay and the quantity used is just as important as the type of opacifier.

Effect of Enamel Preparation The preparation of the enamel for application is the next factor which causes color variation. The enamel which is ground coarse will produce a different color than an enamel which has been ground fine. Over-grinding usually causes the color to become lighter. C. W. Mehling[2] has thrown considerable light on the importance and method of grinding enamels uniformly.

Effect of Enameling Temperature The last factor and perhaps the most common cause of color variation may be attributed to the firing or fusing of the enamel to the ware. Enamel which is not fused at the proper temperature, being either overfired or underfired may be expected to show a wide variation from the original or standard color.

[2] C. W. Mehling, "Control Raw Material Processing to Avoid Defects in Enamelware," *Ceram. Ind.*, **11** [6], 572–76(1928); see also *Ceram. Abs.*, **8** [2], 97 (1929).

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A DEFORMATION STUDY OF COBALT OXIDE-IRON OXIDE-SILICA MIXTURES[1]

By John F. Shepherd

ABSTRACT

Deformation eutectic fusions are reported for 46%Co_3O_4-54%Fe_2O_3 and 36%Co_3O_4-42%Fe_2O_3-22%SiO_2. Either of these eutectics could be substituted for cobalt as an enamel ground coat.

Introduction

The general opinion is that cobalt oxide is an essential ingredient in ground coats. One theory is that the cobalt oxide is reduced leaving metallic cobalt which alloys with the steel. This alloy is believed to be very porous and spongy thus allowing the enamel to "take hold."

Only the cobalt oxide–silica system has been studied. This was done by Felton[2] and he found the deformation eutectic mixture of those two oxides to be 68% Co_3O_4 and 32% SiO_2 with a fusion temperature of 1325° C. The object of this investigation is to study the cobalt-iron and the cobalt-iron-silica eutectics. This has been done by determining the fusion behavior of the mixtures as molded into pyrometric cone shapes.

Cobalt-Iron Series

In the figures, deformation is plotted against composition, the curve representing temperature. The method for grading the deformation is by using the right side of a clock face for a graduate to denote extent of bending of the cones. For example a cone straight up, showing no deformation, would be 0:00, a cone half way down would be 3:00 and one all the way down would be 6:00.

Several mixtures of cobalt oxide and ferric oxide were tested first by 20% variation, then 5%, and finally by 1% variation in proportions. Only the final series will be given.

Table I

1% Variation Study

No.	Co_3O_4 (%)	Fe_2O_3 (%)	Deformation
32	38	62	0:00
26	39	61	1:00
18	40	60	4:30
27	41	59	0:30
28	42	58	1:00
29	43	57	3:00
30	44	56	3:00
25	45	55	5:30
31	46	54	6:00

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Enamel Division.) A thesis presented for degree of Bachelor of Ceramic Engineering, Ohio State University, 1928. Received Jan. 12, 1929.

[2] "A Deformation Study of Cobalt Oxide-Alumina-Silica Mixtures." To be published in this *Journal*.

Numbers 31, 25, and 18 were judged the least refractory. Number 32 showed no evidence of deformation whatsoever, and under microscopic examination, 31, 25, and 18 showed eutectic formation. A check determination was therefore run on these three.

TABLE II

No.	Co_3O_4 (%)	Fe_2O_3 (%)	Deformation
18	40	60	4:00
25	45	55	5:00
31	46	54	6:00

These results definitely place the eutectic at 31, although cones 25 and 18 are very near.

Another fusion was made with the following cones to show that the eutectic was not a mixture with higher Co_3O_4 content.

TABLE III

No.	Co_3O_4 (%)	Fe_2O_3 (%)	Deformation
31	46	54	6:00
56	50	50	3:00
19	60	40	1:00

The results of this fusion show that 31 is the eutectic mixture and, with increase in Co_3O_4 content, the cones became more refractory.

The results of the cone fusion tests are shown in Fig. 1.

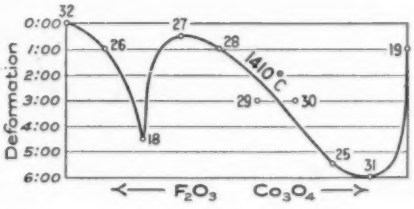

FIG. 1.

A microscopic examination of the eutectic showed that the ferric oxide had been changed to ferroso-ferric oxide. This was either due to the reduction of the cobalto-cobaltic oxide, or to the condition of the furnace. The fusion temperature of 31 is cone 14 or 1410°C.

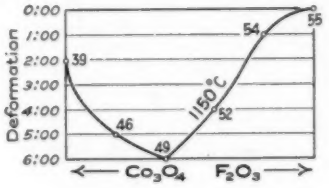

FIG. 2.

All mixtures of cobalt and iron oxides when fused had a metallic luster when fired and in the pulverized state a steel gray color, no variation being evidenced.

Cobalt-Iron Oxide-Silica Series

The eutectics of cobalt and iron oxides and cobalt oxide and silica were now connected by a straight line and a series of fusions made on this line. Fusions were also made of several other mixtures proving that the eutectic of cobalt, iron, and silica oxides does not lie on the line connecting the two component eutectics, but that it is higher in iron and silica.

There is a very definite line on which low fusing mixtures are obtained and on either side are comparatively refractory mixtures. All compositions along this line have a tendency to core and slump over if heated too fast.

The results of a study of this line are as follows:

No.	Co_3O_4 (%)	Fe_2O_3 (%)	SiO_2 (%)	Deformation
39	48	34	12	2:00
46	42	38	20	5:00
49	36	42	22	6:00
52	30	46	24	4:00
54	24	50	26	1:00
55	18	54	28	0:00

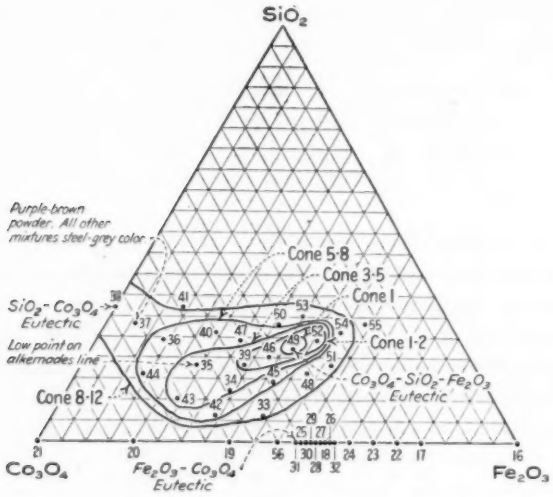

FIG. 3.

See Fig. 2. Mixture 49 is the eutectic of the three oxides. Mixture 55 did not fuse completely and indicates that a refractory condition exists with an increase in the iron and silica content with a lowering content of cobalt.

The fusion temperature of 49 is cone 1 or 1150°C.

See Fig. 3 for isotherms of fusion points as determined in this study.

Conclusions

(1) The deformation eutectic temperature of the iron oxide (Fe_2O_3) and cobalt oxide (Co_3O_4) is 1410°C and the composition is 46% Co_3O_4 and 54% Fe_2O_3.

(2) The deformation eutectic temperature of iron oxide (Fe_2O_3),

cobalt oxide (Co_3O_4), and silica (SiO_2) is 1150°C, and the composition is 36% Co_3O_4, 42% Fe_2O_3, and 22% SiO_2.

(3) The color of the fused cones is uniformly steel gray, the only variation being near the cobalt oxide-silica eutectic.

(4) The eutectic mixtures of either cobalt and iron oxides or cobalt and iron oxides plus silica exhibit the same physical properties as fused cobalt oxide and, therefore, they might be substituted for cobalt oxide in ground-coat enamels with a lowering in firing temperature and cost.

(5) The common belief that the alloy between steel and cobalt oxide is spongy and porous might in some degree be verified by the honeycombed structure of some of the iron and cobalt cones.

THE INCRUSTATION OF CERAMIC WARE[1]

By Theodore Lenchner

ABSTRACT

The history and evolution of the application of gold and other precious metals over acid-etched designs on glass, china, and enamel ware is discussed. Details involving the preparation of the plate and transferring of the design to the article are briefly outlined and also the acid treatment of the article. The application of the metals, and finally a résumé of the incrustation as a decoration is given.

Introduction

The term "incrust" or "encrust" is defined in the dictionaries as an overlaying or inlaying of any material over another material. In modern ceramic decorative practice the word incrust is used to indicate the overlaying or inlaying of any precious metal or alloy over an acid-etched design and fixation to the surface by firing. Since gold is the most used of the precious metals, the decoration is most often referred to as gold incrustation. This paper will deal with incrusted ware within the scope of the definition given above.

History

Ceramic history indicates that the use of metallic gold as decoration dates back to the time of the ancient Greek potters, who attached gold foil to the surface of their clay ornaments or vases by means of a size. As far as can be ascertained, the precious metals were not fired on clay ware until about 1760, which is shortly after the time ascribed to the origin of copper plate engraving and printing on pottery in England. It is, therefore, believable that the modern gold incrustation must have been evolved through the development of the latter art, as the many points of similarity will show.

The modern process of applying the precious metals over acid-etched designs on china is claimed to have been first used by a glass worker, Hughes, employed at the Minton factory at Stoke-on-Trent, England. This process was patented about 1862 for use on china and was known as The Hughes Process of Embossed Gilding. It is, therefore, safe to assume that the etching of glass from a plate was used previous to this time and originated in the glass industry. At any rate, shortly after this, the art of incrusting became popular over all Europe on both glass and china. This was brought to the United States as a decoration on china and involved the highest grade of technique and craftmanship. It has reached such a state of development that it has become one of the foremost expressions of decorative design under mass production conditions. This is especially the case in American china and glass decorating shops of the

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Art Division.)

better type. While at first content to imitate the designs of Minton, American creative ability and ingenuity has now progressed to such an extent that we can successfully compete with foreign incrusted ware.

Etching of the Plate

The process as it exists in this country today, consists of three steps: (1) the etching process, known as deep plate etching, (2) the transferring of the design to the object, and (3) the application of precious metal and fixation by firing. The design which is to be etched is drawn on thin tissue paper, the dimensions and curvature of which very closely and carefully conform to the size and shape of the object to be decorated. A highly polished steel plate, about $^1/_4$ inch in thickness with a smooth, uniformly hard surface is coated with a preparation consisting for the most part of mixtures of beeswax, black asphaltum, and stearin, melted, and placed in suspension in heated turpentine. A typical formula is as follows: 50 parts black asphaltum, 15 parts stearin, 30 parts beeswax, 4 oz. lamp black, in 200 parts turpentine. Such a solution is called the etching resist. After the etching resist has cooled sufficiently to present a hardened surface, the drawing is then placed on the coated steel plate, and the design traced thereon through the tissue. The resist is now traced through to the steel surface, or removed with a steel point or an engraver's needle in such a manner that only the lines and elements of the design which are to stand out in relief on the finished ware will be exposed to the acid treatment which follows. The underside of the plate is now coated with the resist and then the plate is immersed in a dilute solution of nitric acid until the etching of the exposed design on the plate is of the depth required by the decorator. The plate is now washed and the etching resist removed, *e.g.*, by immersing the plate in boiling water, or washing with turpentine. It might be well to mention at this point, that much of the labor of tracing can be avoided by the use of photography, but for some reason, this method is not considered as good craftmanship as the old hand method of tracing, and is seldom used.

Transferring Design to Object

An acid-resisting ink is then spread over the design and worked into all details of the etched plate. A typical formula for this ink is a molten and warm mixture of three parts beeswax, one part asphaltum, one part rosin, one part lamp black, suspended in warmed turpentine. The surplus resist ink is then scraped off with a steel knife, and the plate wiped clean, leaving the etching well filled. A special printing paper is used as a transferring medium. This paper is placed carefully over the filled-in design and its reverse side rubbed down freely and evenly with a

rubbing brush or printing flannel, until the paper when lifted away from the warm plate, shows the design in resist ink impressed thereon. The resist print is the reverse of the usual printing method. The printing of the resist now forms the protective element, the other portions of the design being left blank and subject to an exposure to acid treatment later in the process. The print is then placed accurately on the article to be etched, and rubbed down firmly and evenly with a piece of felt. The paper is then moistened thoroughly with dilute denatured alcohol, after which it can be easily removed and the resist ink design will remain on the article.

Etching of Ware

The object, with the exception of the resist ink pattern and the area immediately surrounding the design, is then coated with molten paraffin or wax by brushing or dipping. This leaves exposed only that portion of the surface which is to be etched, the design proper being protected by the resist ink. Obviously, when the etching is completed the design will stand out in relief. The etching solution varies with composition of the surface to be etched: the higher the silica content, the more concentrated the acid. A typical solution for etching soda lime glass would be as follows: 6 parts hydrofluoric acid, 1 part sulphuric acid, and 3 parts water. The operator, with gloved hands and under conditions of room temperature most suitable for etching, immerses the ware in the etching solution and allows it to remain until the required depth of etching has taken place. The object is then placed in boiling water, which will melt the wax and the resist ink, causing these to flow off the ware. If the procedure is properly carried out to this point, the relief design will be reproduced exactly as in the original drawing, even hair lines or dots being reproduced exactly.

Application of Precious Metal

The overlaying or inlaying of the metal, usually gold and sliver, is fairly simple if the metal is to be fired on the object. For this purpose, a preparation containing the metals, usually very finely powdered and thoroughly ground with suitable carrying vehicles and fillers in either paste or semi-liquid form, is used. This is painted over the whole of the etched design or filled into the design and fired to temperatures ranging from 900 to about 1500°F, the time and temperature of firing depending upon the nature of the object, whether glass, china, or enamelware. After firing, the metal is polished by means of a burnishing sand, glass wool brush, or agate tool, thus completing the decoration.

Electro deposition of metal, especially silver, has been practiced in this country for some time. In this instance, a base consisting usually of

silver oxide, with proper carrying vehicle, is applied and fired exactly as described above, after which the ware is placed in an electrolytic solution of silver cyanide with the proper contacts. The metal is allowed to deposit on the silver base, until a sufficient depth of metal is deposited thereon. It is obvious that the design must be continuous so as to avoid too many contact points.

Conclusion

Originally the incrustation was used chiefly as a border decoration, both in this country and abroad. The designs were simple, and in keeping with the use and purpose of the article. However, recently very elaborate incrusted designs have appeared, sometimes an inch or two in diameter, and even the entire article has been incrusted. Accurate and neat workmanship will do much to maintain confidence in the gold incrustation. Careless, cheap, and rapid work, encouraged under the stress of modern competition, will surely spell its doom. There is altogether too much poorly incrusted ware evident in the market, and a lot of it is overdone.

There are possibilities in its use. Improved designs should add greatly to its prestige. The decoration should add interest to the shape of the article. Elaborate incrustation should be avoided, and the elements of the design must flow from one to another. The incrustation must have a definite purpose.

Very little has been done in the application of this to enameled steel, yet it is felt that incrustation should lend itself to artistic expression on decorative enamel ware and on small signs. To the decorator of enamel ware, seeking elegance, the incrustation offers a field scarcely touched.

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LINOLEUM BLOCK PRINTED POTTERY[1]

By Sadie Loshinsky

ABSTRACT

A study of three methods for applying color to pottery with linoleum designs is presented. The procedure is practical for studio potters and small factories rather than for quantity production.

Introduction

Of all the arts of decoration, people seem least familiar with block printing, for it is an indirect method of decoration. A design is cut from a wood block or linoleum surfaced block, the essential part of the design is allowed to remain while the background is cut away. This raised part receives a coating of ink or paint, and is then applied to the material to be decorated, thereby transferring the design to the material.

The Eastern and Oriental countries particularly used this method which may be seen in the many examples of Japanese and Persian prints. In time this art was carried West where in the early centuries it was used extensively. It was during the periods of individual artists and home crafts that this art flourished. But with the approach of machinery it became the precedent for machine printing and from copper plates, more durable than the wood blocks, but not so interesting in design or texture. That personal and intimate feeling of a hand-cut block was lost on the copper plates of the machine. Nevertheless artists and craftsmen continued to cut blocks and to print them by hand.

The art of block printing is being appreciated again, and there are to be found many hand-blocked materials, as prints, illustrations, labels, cards, and textiles. At present the designs are not always cut from wood, but often from linoleum which is a very similar medium and easier to cut. The design it produces is not quite as fine but the texture is the same, and the same feeling can be put into the design while it is being cut.

This method of decoration has been applied to many materials, but seldom to pottery. During the Rennaissance when both hand blocking and machine printing were at their height, a print was found that could be used on pottery, the decalcomania print; but this did not produce a block design and was very difficult to make. Therefore the number of designs was limited and these were reproduced innumerable times, the pottery losing that individual touch of a hand-decorated piece.

A block print can be used again and again and still preserve the original freshness of design, and many designs can be cut at very little expense. The purpose of this paper is to show how hand-blocked prints can be applied to pottery.

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Art Division.)

Application to Pottery

A design must be created, drawn accurately, transferred to the block, and cut the same as for regular block printing. The design may be applied to both flat and curved surfaces. If it is to be applied to a curved piece the pattern must be drawn directly on the piece, and, if to be repeated, very carefully spaced so that the repeats will fit into each when later placed on the clay. One-color or many-color designs may be used. In the use of more than one color a series of blocks must be made, one for each color. After the design is drawn on the piece a transfer paper is placed over it and cut into any shape necessary to make the paper fit the curved surface. The design is rubbed off onto the paper and then placed on the block and cut.

For regular block printing, oil, paints, and printer's ink are used, but for printing on pottery, underglaze and overglaze colors are required.

The underglaze color to be used for this purpose must be properly fluxed with about 10% of the same glaze that is eventually to cover the piece. This is then mixed with a sticky bonding medium, as English printing oil, and, if necessary, thinned a little with turpentine, and in some cases with linseed oil. The quantity of these oils will depend on the colors used, which vary greatly.

The composition of the glaze will of course affect the color. The dry color and glaze are first mixed very thoroughly by grinding in a mortar and then moistened with a little turpentine. To this mixture the English printing oil is added, enough to make a thick, sticky substance of about the same consistency as printer's ink or oil paints. Turpentine evaporates very quickly leaving the mixture of color and English printing oil alone, which may not level itself on the roller readily to make a smooth print, so a little linseed oil is added. This mixture is rolled out on a glass plate with a printer's roller and applied directly to the block.

Application There are three methods by which this color can be applied to the piece of pottery. In all of them, however, the color is mixed in the same way using the same materials.

Biscuit Surface The color, having been mixed, is applied to the ready block by means of the roller giving it as even and smooth a coat of the thick, sticky mixture as possible. The block is then placed on a transfer paper, which is a sized tissue printing paper, and rubbed down until a good print is obtained. The edges of the paper should be trimmed as closely around the block as possible. The paper is then removed and applied to the biscuit where it is once more rubbed down with a slight pressure of the finger tips. After sufficient rubbing, the paper is removed leaving an imprint on the body. This is left to dry and the piece then fired at a fair red heat to remove from the color the

carbonaceous material of the oils that were mixed in it. After this firing it is covered with a transparent glaze and fired again to maturity.

Smoother, Thinner Prints The color is mixed as before with the flux and printer's oil, but this time a little more linseed oil is added. This is rolled on the block and transferred to the paper as before, but instead of immediately applying the print to the body, the paper is allowed to dry a while until the print becomes smooth and tacky. It is then put on the biscuit and rubbed down very well. It is left on the body until as much color as possible is transferred to the piece and then removed. This too is fired twice as in the first method.

Vitrified Body This time the biscuit is sprayed with a decalcomania varnish, the thickness of the varnish varying with a soft or vitreous body. The varnish is then left to dry until it becomes tacky. The print is made in much the same way as in the second method. More linseed oil is added, and the print is allowed to remain on the paper until tacky before putting it on the body. When both surfaces have become sticky the print is applied and well rubbed down. The print is then allowed to dry on the body and when dry the paper is removed by soaking the piece in water. The paper will come off easily because of the sizing in it. When dry this piece too is fired twice, once to remove the organic materials in the color, and a second time when the covering glaze is applied.

These have been the methods used with underglazes. The process with overglazes is very similar to that of the last mentioned. The color need only be mixed with the English printing oil and a little turpentine or linseed oil. The piece having already been glazed, will have a slick surface which should be covered with a diluted decalcomania varnish, a surface to which the print will stick. The print is allowed to stay on the body until dry, and, as before, is removed by soaking in water. The piece is then ready to be fired under oxidizing conditions to the softening point of the color.

By these methods of overglaze and underglaze block prints can be applied to pottery as another means of decoration. At present it may not be so economical for quantity production as other prints now used by pottery manufacturers but it can very well be used by studio potters, small factories, or for special orders where individual patterns and an intimate feeling is desired in the creation. So, in time, there will be seen hand-blocked pottery as lovely in design, feeling, and texture as is found in the many other hand-blocked materials used today.

University of Cincinnati
Cincinnati, Ohio

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

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Vol. 8 **July, 1929** **No. 7**

Author Index to Ceramic Abstracts for July[1]

AUTHOR	PAGE
Abbott, L. S.	509
Abrasive Wheel & Equipment Co., Inc.	471
Alferink, W.	497
Allen, J. H. D.	474
Allison, L. W.	495
Andrews, A. I.	485
Angus-Butterworth, L. M.	496
Armour, J. W.	536
Ashby, T.	480
Arnold, R. E., and Duncombe, G. H., Jr.	509
Austin, A. O.	515
Avanzini, L.	504
Azbe, V. J.	482
Bachmann, W.	534
Bailey, F. J., Gregson, W., and Reber, J. W.	536
Bandini, F.	504
Barth, T.	528
Bary, P.	532
Beach, H. C.	468
Becker, C. A., and Kraft, C.	495
Behl, K.	484
Berger, E.	494
Billiter, J.	525
Binns, G. W.	468
Blair, M. W.	501
Blumenfeld, J.	534
Blythe, G. E. K.	536
Bonner, J. M., Jr.	481
Bosler, L. C.	524
Bouffioux, A.	498
Boyleston, H. M.	517
Bramley, A., and Turner, G.	488
Brook, G. B., and Simcox, H. J.	532
Brooke, H.	497
Brush, G. S.	481
Bryant, L. N.	482
Buell, W. C.	523
Cappelman, J.	492
Capstan Glass Co.	499
Carborundum Co., Ltd.	471
Cartwright, V.	529
Caton-Thompson, G.	480
Chapell, R.	473
Clive, K. V.	477
Cole, S. S.	524
Cole, W. G.	540
Collis, E. L.	514
Colman, H. D.	469
Compagnies Réunies des Glazes et Verres, etc.	499
Constable, F. H.	485
Coster, F. D.	481
Coulter, W.	516
Coulter, W., and Burslem Productions, Ltd.	515, 516
Cramer, W. E.	503
Crane, J. B.	536
Cronshaw, H. B.	524
Curtis, E. de F.	535
Dailey, J. B.	469
Dall, L. A.	468
Daniels, F. H.	521
Davis, A. C.	484
Davis, C. W., and Messer, L. R.	529
Davis, F.	478, 480
Delmotte, D. J.	508
De Luce, R.	484
Deutsche Gasglühlicht-Auer-Ges.	489
De Vlieg, G. A.	468
Dicker, S. G. S.	498, 499, 500
Diepschlag, E., and Feist, K.	507
Dithridge, J. D.	481
Dorrington, B. J. F., and Ward, A. M.	531
Douglas, R. C.	467
Drinkwater, F. L.	513
Dronsfield, J.	472
Dudgeon, H. A.	469
Durner, H. B.	469
Eckhoff, W., and Deussener, L.	490
Edwards, H.	537
Emery, W.	505
Escofet, J. M.	521
Falk, K.	507
Fatscher, G. C., and Billings, C. E.	521
Forse, E. B.	509
Forsén, L.	484
Fortune, J. B.	508
Friedrichs, F.	494, 495
Frink, R. L.	509
Gammeter, J. R.	468
Gareau, N. J.	533
Garve, T. W.	501, 502
Gear Grinding Co., Ltd., Orcutt, A. H., and Snarry, J. W.	472
Gehlhoff, G., and Thomas, M.	490
Gensbaur, M.	482
v. Girsewald, C.	533
Goddard, J. V.	481
Goldhaber, J.	481
Goodlet, B. L.	513
Goodwin, J. E.	481

[1] The abbreviations (*C.A.*) at the end of an abstract indicate that it was obtained from *Chemical Abstracts* by coöperative agreement.

The bold-face number following the journal name is the volume, the issue number is in brackets, followed by the page numbers, then the year in parentheses.

AUTHOR	PAGE
Grancsay, V.	478
Greaves-Walker, A. F.	507
Grigg, C. L.	481
Groniger, W. E.	481
Gruen, R.	483
Grunwell, P. C.	519
Gwosdz, J.	525
Haegermann, G.	484
Hagan, N.	478
Hagar, E., and Flood, L. W.	506
Hagmann, U.	481
Hagopian, V.	481
Haley, W. D.	539
Hampton, W. M.	476
Hancock, W. C., and Cowan, J. G.	505
Haniman, C. J.	509
Hanson, B. M. W.	467
Hardinge, H.	519
Hardy, A. C.	476
Harlow, F. H.	529
Harmon, M.	476, 513
	519
Harraeus	522
Harrop, C. B., and Orth, H. S.	531
Hatschek, E.	504
Heil, A., and Keller & Co., Ges., C.	508
Heinrich, K.	512
Henry, E. C.	523
Hepburn, W. M.	523
Herron, J. H.	499
Heuze, C.	504
Hewitt, L. C.	516
Hill, F. A., and Doulton & Co., Ltd.	523
Hind, S. R.	478
Hinks, R.	514
Hinsdale, W. E.	540
Holden, P. E.	508
Holland, W.	528
Holmes, A.	475
Hood, B. M.	525
Hruska, J. H.	470, 471, 473, 474
Hughes, V. A. B.	505
Hughes, W.	520
Hull, F. J.	530
Hyslop, J. F.	533
I. G. Farbenindustrie Akt.-Ges.	508, 525
Illies, H.	494
Ingalls, A. E.	508
Jackman, A. J.	513
Jackson, C.	497
Jaeger, M.	500
Jobling & Co., Ltd.	482
Johnson, E. L.	481
Johnson, J. G.	519
Judelson, J.	504
Kall, G. A.	532
Kallauner, O.	468
Kearns, B. A.	533
Keffer, R.	511
Kelso, J.	539
Kieffer, E.	528
Kindle, E. M.	536
Kleinschmidt, R. V.	513
Knittle, R. M.	510
Knudsen, G., Goldschmidt, V. M., and Knudsen, R.	507
Knuth, H.	540
Koch, W. C.	530
Konarzewski, J.	492
Krak, J. B.	511
Kraner, H. M.	526
Ladoo, R. B.	503
Lafon, P.	509
Lambie, J. M., and Ross, D. W.	472
Landis Tool Co.	515
Lapp, J. S.	510
Lean, C.	480
Lenchner, T.	519
Lent, H., and Kofler, F.	513
Leonhardt, E., and Zschimmer, E.	527
Lerch, W., Ashton, F. W., and Bogue, R. H.	477
Levetus, A. S.	538
Lewis, H. H.	487, 507
Linke, W.	494
Lipkin, L.	507
Litinsky, L.	524
Loeser, C.	468
Long, E. M.	537
Longenecker, C.	507
Lorenzen, G.	502
Louis, L. R.	506
Lowe, R. E.	529
Lucas, H. J.	503
Luce, G. E.	508
Luftschitz, H.	531
Lundell, G. E. F., and Hoffman, J. I.	511
Luther, F. P.	513
Lyons, T. E.	502
Lysle, F. B.	528
MacCoy, F.	539
MacKelcan, H. G.	498
Madden, H. de F.	477
Maltby, H. J. M.	469, 470, 490, 510
Marks, E. C. R.	529, 535
Martin, G.	537
Maynz, T.	535
McAfee, W. K.	535
McDermoth, G. R.	525
McDougal, T. G.	508
McLachlan, J., and Otto, C. A.	477
Meyer, O.	481
Miller, F. R.	515
Mitchell, J. R.	526
Molle, O., and Ateliers J. Handrez Soc. Anon.	535
Möller, W., and Zschimmer, E.	521
Morin, W. T.	476
Morris, L. B.	527
Morris, T. O.	493
Morton, W. A.	505
Moulton, D. A.	515
Mueller, P.	480
Mühlestein, H.	485, 489
Nealey, J. B.	538
Newhall, P. M., and Pryce, L.	488
Osann, B.	515
Osborne, D. H.	483
Obst, W.	532
Othmer, D. F., and Coates, H. B.	517
Otis, A. N.	533
Page, L.	540
Parker, L. T.	500
Parmelee, C. E.	525
Passauer, H.	531
Pfefferkorn, K.	507
Philipp, O.	482
Pike, R. D.	498
Pirani, M.	516
Pitt, S.	519
Place, C. E. S.	539
Plank, W. B.	482
Platzmann, C. R.	540
Poland, C. D.	477
Polka, O.	517
Pollak, J. E.	516
Porzellanfabrik Hentschel, and Müller	480
Priest, A. R.	469
Probert, S. C., and Spurr, R. E.	482
Pruessing, C., and Gruen, R.	475
Ramsdell, H.	541
Reber, B. C.	524
Renkin, W. O.	480
Richmond, O. L.	479
Richter, G. M. A.	477
Riggs, A. S.	526
Robertson, H. M.	507
Robinson, P. B.	540
Rogers, F. H.	479
Rorimer, J.	

AUTHOR	PAGE
Routt, J. R.	481
Rossman, J.	494
Russ, A.	495
Ryan, W. D.	539
Sauermann, A.	535
Scharf	539
Schefold, M.	480
Schneiderhöhn, H.	482
Schofield, R. K., and Keen, B. A.	529
Schroeder, B.	509
Schuette, C. N.	538
Scott, F.	483
Scott, W.	537
Searle, A. B.	511
Searson, T.	522
Sherman Corp.	540
Sherrick, P.	511
Siroky-Sidney, J.	476
Smith, D. F., and Hartgen, F. A.	530
Snelgrove, A. K.	528
Soc. Anon. des Ateliers Heuze, Malevez, et Simon Réunis	498
Soubier, L. D.	497
Springer, L.	495
Steiner, A. P.	469
Stenhouse, D.	498
Stevens, E. P.	509
Stewart, P. M., and Ratcliffe, G. H. C.	504
Stock, A. M.	517
Stoddard, B. H., and Dorsey, J. A.	526
Story, W. R.	476
Straight, H. R.	526
Sullivan, J. M.	489
Swain, R. E.	494
Syssojew, A. N.	519
Taylor, E. R.	486
Teahen, J. M.	515
Thorley, J. P.	474
Thornburgh, C. G.	481
Thorngate, B.	481
Tippmann, O.	524
Toohey, W. A.	483
Tools, B. S. A., Ltd., and Ogilvie, W.	471
Trethowan, H.	476
Troop, R. S.	518
Umino, S.	532
Vickers, A. E. J.	529
Voisin, U. B.	509, 534
Ward, A. C.	525
Walter, C. M.	523
Washburn, E. W.	531
Waterfill, R. W.	537
Watson, H. L., and Abrams, H.	517, 532
Wedgwood, J. C.	514
de Weerdt, H. E.	493
Weiss, H.	532
Welles, A.	480
West, C. H.	481
Williams-Thomas, J. S.	478
Williamson, J.	522
Wilson, T. A.	486
Wimsatt, G. B.	480
Wintermeyer	525
Wohrman, C. R.	488
Wolf, J.	476
Wotan-Werke Akt.-Ges.	472
Wright, W.	475
Young, L. E.	478, 539
Zander, J. M.	502
Zschimmer, E.	494, 539

Abrasives

Biefnes' cutting diamonds. ANON. *Nat. Glass Budget*, **45** [1], 23 (1929).—As diamonds are costly, a knowledge of their usefulness and value as compared with other stones for glass cutting is important. Special types of diamonds employed are called "sparks." Sparks are small, perfectly formed little crystals, ranging from one-quarter carat to a powder. They are six-pointed and brilliant, hence many have the idea they are polished. This is incorrect. They are used exactly as they come from the mines, in fact, the original outer surface, or "skin," is the best cutting medium. Sparks are found mainly in S. Africa and also in Brazil and Australia. They have a variety of colors: white, yellow, light and dark brown being most common. Theories differ as to why sparks cut glass. Sparks do not truly cut. The mark made on glass is extremely light. The spark will deal rapidly and accurately with a great quantity of work. Sparks are next to diamonds in hardness, they are brittle and very sensitive to knocks and jars.

E.P.R.

Uses of grinding wheels and grinding machines. R. C. DOUGLAS. *Eng. Jour. Can.*, **12** [2], 48–50 (1929).—Few people realize how greatly the development of abrasive processes has contributed to the mechanical improvement and reduced prices of articles. The vitrified wheel is used most whether the abrasive be natural like emery, or artificial silicon carbide. Bakelite and rubber-bonded wheels can be used at higher speeds. Progress has been made in multiple diameter work, wider face, and larger diameter wheels, and heavier machines.

H.H.S.

PATENTS

Grinding machine. BENGT M. W. HANSON. U. S. 1,709,617, April 16, 1929. A machine having a support mounted for angular adjustment about a vertical axis, a rocking bed mounted on the support for rocking-movement about an axis substantially normal to the 1st axis, means on the rocking bed for rotatably supporting a piece of work

with its axis substantially parallel to the 2nd axis, a grinding wheel mounted for adjustment in a plane passing centrally through the cutting edge of the wheel and including the first axis, and means for rocking the bed.

Grinding machinery. BERNARD A. KEARNS. U. S. 1,709,671, April 16, 1929. A steady rest mechanism, including a supporting member, a steady rest shoe carried thereby having an angle top work engaging surface for line contact with the work at one side of the axis thereof, and a contact roller also carried thereby and positioned to engage the work of the opposite side of the axis thereof.

Grinding. GEORGE W. BINNS. U. S. 1,709,818, April 16, 1929. A centerless grinder including opposed grinding and regulating wheels, the grinding wheel having a portion adapted to produce cylindrical and noncylindrical portions on a work piece, and a regulating wheel having a work controlling portion engaging and urging a cylindrically shaped portion of the work piece toward the grinding wheel whereby the work is reduced to a contoured form contrageometric to that imposed on the surface of the grinding wheel and is controlled in its rotation by the engagement of the regulating wheel with the cylindrical portion thereof.

Abrasive wheel. JOHN R. GAMMETER. U. S. 1,709,820, April 16, 1929. An abrasive wheel having face plates on the opposite faces thereof, each of the face plates being integrally secured to the wheel by intermediate layers including a layer of rubber and layers of rubber material by which the rubber layer is permanently vulcanized to the plate and to the wheel, the layers being of a total thickness comparable with the coarseness of the stone and filling the interstices in the faces thereof.

Lens grinding and polishing machine. ELI MAYNARD LONG. U. S. 1,709,943, April 23, 1929. In a lens-grinding and polishing machine having an abrasive element and a lens-holding element, a rotary driving shaft having an eccentric, a pitman journaled on the eccentric, a driven shaft journaled on the pitman and provided with an eccentric, means for transmitting rotary motion from the driving shaft to the driven shaft, a yoke journaled on the eccentric of the driven shaft, a pivotally supported frame operatively connected to and oscillated by the yoke, a floating frame operatively mounted on the first-named frame to move therewith in reverse directions and having an independent reciprocal movement in a different direction, means actuated by the driving shaft for effecting the independent movement, and means for transmitting motion from the floating frame to one of the elements.

Lathe or grinder attachment. LOUIS A. DALL. U. S. 1,710,016, April 23, 1929. The combination with a metal working machine, of a driving member provided with an enlarged chambered head, a removable annular member carried by the head and provided with a radially serrated beveled circumferential outer portion constructed and arranged to internally engage a hollow work piece to center the same thereon, a fork-shaped member removably secured in the chamber in the head, the forked end of the latter member adapted to internally engage the work piece for rotating the same upon the rotation of the driving member.

Grinding wheel and holder. HOBART C. BEACH. U. S. 1,710,528, April 23, 1929. In a wheel assembly, a bonded abrasive grinding wheel having a reduced hub portion on one face thereof, a series of radially arranged elements coöperating with the periphery of the hub portion and having inclined peripheral surfaces thereon, a central member about which the radially arranged elements are arranged, a disk on the central member having a flange thereon slidably embracing the inclined peripheral surfaces of the radially arranged elements, and means threaded on the central member for holding the disk in coöperative engagement with the segmental members.

Machine for grinding rotary cutters. GERARD A. DE VLIEG. U. S. 1,710,533, April 23, 1929. The method of relief grinding the helical blades of cutting tools, which com-

prises causing a combined or simultaneous reciprocatory and rotary motion between a blade-holder and a grinding wheel, and causing a relative approaching movement between the blade-holder and the wheel during an intermediate state of such combined reciprocatory and rotary motion to grind a deflected end section on the blade.

Machine for grinding twist drills. SIDNEY C. PROBERT AND ROBERT E. SPURR. U. S. 1,710,647, April 23, 1929. A grinding machine having in combination a rotary grinding wheel, means for holding a twist drill with its axis oblique to the plane of the grinding wheel in position to present the inner face of a lip to the grinding wheel at an angle to give the desired rake, and mechanism for supporting the holding means for movement to carry the inner face of the lip past the grinding wheel in the general direction of the edge of the lip.

Grinding and polishing machine. JOHN B. DAILEY. U. S. 1,711,015, April 30, 1929. In a polishing machine, a support having an aperture therein, a shield member mounted upon the support and positioned in the aperture, a bracket secured to and depending from the member, a motor mounted upon the bracket, a rotatable table, and means for driving the table from the motor, the bracket, motor, table, and driving means being insertable or withdrawable as a unit with the member through the aperture.

Adjustable emery-wheel dresser. HERBERT B. DURNER. U. S. 1,711,343, April 30, 1929. In a device of the class described, a handle, a dresser carried by the handle, an abutment slidable on the handle, a screw threaded into the abutment, and means for holding the screw on the handle for rotation but against longitudinal movement.

Machine for generating gear wheels. HOWARD D. COLMAN. U. S. 1,712,254, May 7, 1929. The combination of a frusto-conical grinding wheel having upon its periphery a plurality of equidistant annular plane grinding surfaces, and means for rolling a toothed blank across the periphery of the wheel with the teeth of the blank in contact with the plane grinding surfaces.

Grinding wheel. HOWARD D. COLMAN. U. S. 1,712,255, May 7, 1929. A frusto-conical gear grinding wheel having upon its periphery a plurality of equidistant annular plane grinding surfaces which are perpendicular to the axis of the wheel.

Work rest for grinding machines. AMOS P. STEINER. U. S. 1,712,314, May 7, 1929. A work rest comprising a stationary frame, an adjustable frame carried by the stationary frame, a relatively fixed jaw, a pivoted jaw beneath the fixed jaw, a curved extension on the rear of the pivoted jaw, a pivoted nut mounted in the adjustable frame, an adjusting screw passing through the nut and bearing against the curved extension to swing the pivoted jaw into operative position, and retractable means for holding the nut.

Machinery guards. H. A. DUDGEON. Brit. 305,824, April 10, 1929. In order to provide greater protection for the grinding wheels of tool-sharpening machines of the kind in which the grinding-wheel spindle is carried by a swiveling-head in an open-fronted casing, wheel guards are so carried by the head as to be capable of axial, radial, or angular adjustments or any combination of these adjustments. As applied to the machine described in Brit. 295,169 (see *Ceram. Abs.*, **7** [12], 805 (1928)) the cast or pressed guard covering half of each wheel is adjustably secured by a slotted lug to a perpendicularly-slotted lug on the work-rest supporting arm which is angularly adjustable about the spindle bearing by means of a slotted lug clamped to the head.

Grinding or abrading machines. E. C. R. MARKS. Brit. 305,831, April 10, 1929. In an internal grinding machine the work is carried on the front end of a hollow work spindle while the grinding wheel is inserted into the work from the rear of the spindle, a truing device for the grinding wheel and a device for gaging the work being also mounted to extend into the work spindle from the end opposite to that at which the work is secured. The spindle is carried in a ball-bearing in a head mounted on the work table

which slides in guides. The front of the spindle is flanged and provided with rings engaging grooves in a ring secured to the head, this arrangement serving to exclude the abrasive from the spindle bearing. The guideway has its front and rear walls disposed at unequal angles to the vertical, the former being at substantially 45°, the latter at about 25° to the vertical. By this construction, the line of pressure of the tool against the work is acutely inclined to the rear face of the guideway, thus forcing the table down firmly on to its bed. The front guide surface is flat to permit expansion or contraction of the table. The work spindle carries a driving pulley driven from an electric motor. A clutch is provided in this train so that the work spindle may be stopped independently of other rotating parts. The grinding-spindle, which is mounted in a head slidable transversely, is also driven from the motor shaft. The cross-feed of the grinding-head is effected through gearing from a handwheel or, alternatively, an automatic cross-feed may be employed. The table is preferably reciprocated longitudinally by hydraulic mechanism, the main valve of which may be operated manually. This control handle is also connected to a valve rod to vary the rate of table traverse. Auxiliary valves may be operated by adjustable dogs on the table to control the extent of the movement. The gaging device comprises a cross-slide sliding in ways on the work head and adjustable through rack-and-pinion gearing from a knob. The contact diamond or steel point is mounted on the short arm of the lever while the long arm engages through a plunger rod with the plunger of a visible indicator. The gage may be adjusted by moving the slide so that a zero reading is obtained when a work piece of standard size is in position. The slide is then clamped and successive work pieces will be ground to size when the gage indicates the zero. The truing device is similarly mounted on a cross-slide adjustable from the head and having an arm carrying the dressing tool or diamond point. Additional clamping screws are provided for locking the slides.

Grinding or abrading machines. E. C. R. MARKS. Brit. 305,832, April 10, 1929. A grinding lathe of the kind in which the work is mounted on a hollow work spindle while the grinding wheel presented to the work from the rear is provided with longitudinally movable supports for a cross-slide which has a portion projecting into the work-spindle and adjustable means for truing the grinding wheel. The work head has longitudinal guides for side members which support the cross-slide, the slide being operated from a head through a spindle, bevel gearing, screw, and nut. A graduated head indicates the extent of the cross-slide movement. A U-shaped member carried by the cross-slide is provided with a holder for a tapered spindle carrying the diamond or other tool, the tool being rotatable, when worn, by worm gearing operated through a spindle and bevel gearing from a head. For adjustment of the diamond point in the direction of the work-axis the side members are traversed along guides by means of rack-bars operated by pinions on a spindle which may be rotated from a head (cf. preceding patent).

Centerless grinding machines. V. A. B. HUGHES. Brit. 305,839, April 10, 1929. In a machine for cleaning up or finishing thin hollow or solid bodies of substantially cylindrical shape but which are slightly conical or noncircular, the work is freely supported in contact with a grinding wheel so as to be capable of angular and lateral movement. The machine comprises a grinding wheel rotated at a high speed by a belt and a regulating wheel rotated at a low speed by a belt, gearing, and a flexible shaft. The bearings for the regulating wheel are carried on a frame pivotally supported by a shaft on a base which may oscillate about a trunnion on a slide movable to and from the grinding wheel by a hand wheel. The base is provided with rollers to assist the freedom of oscillation about the trunnion and the frame is supported at the rear by plungers urged by springs against studs on the base, the pressure of the springs being adjustable by nuts. The regulating wheel is moved to and from its operative position by a pedal and a link attached to the frame. In operation, when the regulating wheel has been with-

drawn by the pedal, the work is placed upon a roller rotatable on a bracket attached to the slide and is kept in position by a fixed blade on the base. The regulating wheel is then allowed to come in contact with the work and presses it, by means of the springs and a weight, against the grinding wheel in such a manner that the latter is able to grind it uniformly all over without removing an undue amount of material at any point.

Grinding cylindrical bodies. B. S. A. Tools, Ltd., and W. Ogilvie. Brit. 306,177, April 17, 1929. In a centerless grinding-machine wherein the cylindrical work is supported on a rest between peripherally opposed grinding and control wheels, the rest is provided with an adjustable and renewable wearing-bar. The bar is of circular or polygonal cross-section and is supported in a groove in the base of the work-carrier. The groove may be undercut so as to prevent displacement and lifting of the bar, and, adjacent the bar, transverse holes may be formed for screws which press clamps against the bar. The carrier may be slotted below the bottom of the groove so that it may be pressed up to the bar by transverse screws. In a modification, the groove has its side walls of unequal height, but is formed to envelop more than one-half of the bar as in the construction described above. When the acting surface of the bar is worn, the bar is turned in the groove, notches in the bar or an index-plate indicating the degree of angular adjustment. The carrier has slots therein for the usual adjustment of the inclination of the carrier.

Centerless grinding machines. V. A. B. Hughes. Brit. 306,710, April 24, 1929. In a centerless grinding machine of the type in which the work is held in contact with the regulating wheel by gravity, means are provided for varying the inclination of the work-supporting surface with respect to the operative surface of the regulating wheel so as to vary the pressure of contact between the work and wheel. The machine comprises a bed, hollow throughout in order to accommodate some of the driving mechanism, and provided with horizontal ways. Spaced bearings on the slide support the shaft for the regulating wheel which is preferably composed of abrasive such as emery, and between the bearings is the driving pulley. Further ways inclined to the horizontal at an angle of about 45°, support a slide which carries the bearings for the shaft of the grinding wheel, the drive being by means of a pulley. The grinding wheel is driven from a main belt-driven shaft through a belt whose tension is maintained throughout the movements of the slide by means of a jockey pulley carried by a pivoted arm, and an idle pulley on a fixed shaft engages the tight side of the belt. The regulating wheel is driven by a belt, provided with a jockey pulley, from a lay shaft which is connected by a belt and cone pulleys to the main shaft.

Abrasive tools. Carborundum Co., Ltd. Brit. 306,734, April 24, 1929. An abrasive tool consists of bonded abrasive material molded to trapezoidal cross-section, and tapered lengthwise. The tool may consist of two layers of different coarseness; a handle may be fitted. In the production of a tool having the two layers the bottom layer is pressed in a straight-sided mold, the top layer is added and pressed, the pressed body of rectangular cross-section is then cut to trapezoidal section, and the shaped block is fired. In order to counteract uneven shrinkage during firing, the lower and upper surfaces of the molded block may be curved as shown in dotted lines. The two layers of the composite tool may be formed separately and cemented together.

Expansible abrading wheels. Abrasive Wheel & Equipment Co., Inc. Brit. 306,946, April 24, 1929. An expansible wheel device particularly adapted to be fitted with a peripheral band of abrasive or polishing material comprises a number of rim elements which may be expanded and secured against centrifugal forces by means of flexible side plates actuated by a central screw. A central disk, built up of disk elements separated by a spacing plate is fitted with a number of independent rim segments. Each segment having a tongue sliding between the disks and having limited radial movement

therein by means of rivets and slots. The side edges of each segment are grooved, these grooves being adjacent to inclined faces which are adapted to coact with faces of a pair of flexible steel side plates. These plates are secured to hub members, and are forced together to expand the wheel by means of a nut screwing on a central spindle. In the expanded position, beads on the side plates engage the grooves to hold the rim segments firmly in position. The segments are additionally secured by the engagement of the rivets with the ends of slots. Each rim segment carries a plate fitted with longitudinal cleat members which are of flanged channel section. The flanged portions are provided with extensions, the latter being slightly raised so that when the rim elements are assembled the extensions interengage to form continuous rings. The body portions of the rim segments are hollowed out to reduce weight. An annulus of rubber or other elastic material is formed over the members on the cleats while the wheel is contracted, this annulus having thickened portions so that a circular face is obtained when the wheel is expanded. A continuous band of emery cloth, sand paper, or other suitable material is slipped over this annulus. It is stated that a wheel of 12 in. expanded diameter, having an annulus $^{9}/_{32}$ in. thick may be run at a speed of 1500–2000 r.p.m. The plates are of dished formation and are strengthened by radial ribs.

Grinding or abrading machines. WOTAN-WERKE AKT.-GES. Brit. 306,973, April 24, 1929. In controlling the operation of grinding or abrading machines, the surface of the grinding wheel (or a surface maintained in definite relation to the wheel surface) is used to actuate an indicator or to make frictional contact with an abutment to close contacts controlling the cross-feed and traverse of the machine. In a modification, a separate disk may coact with the abutment, this disk being reduced by a suitable tool to the same extent as the grinding wheel is reduced by trimming operations. In a further modification, an abutment frictionally mounted in the tool slide may coact with an indicator. In order to compensate automatically for wear of the wheel, when the wheel is moved past a trimming tool the abutment moves past a projection which resets the abutment in its previous position relative to the wheel surface.

Indexing mechanism for grinding machines. GEAR GRINDING CO., LTD., A. H. ORCUTT, AND J. W. SNARRY. Brit. 307,164, May 1, 1929. In indexing mechanism for grinding machines particularly for gear grinders, the blank is mounted on a spindle which is connected to indexing mechanism by means of a pair of gears, cut to a high degree of accuracy. The gear is preferably of larger diameter than the largest gear to be ground. The spindle is carried in a bearing and is secured to a plate having an annular bearing surface.

Grinding wire clothed rollers. J. DRONSFIELD. Brit. 307,208, May 1, 1929. A machine for grinding and burnishing the wire of saw-tooth wire clothed rollers or cylinders consists of connected standards supporting bearings for the roller to be treated, and carrying brackets having flanges on which are mounted disks movable around fixed pivots by teeth which are engaged by pinions on a shaft rotatable, through a worm gearing by a hand wheel. The disks carry angularly adjustable arms, in the ends of which is carried the shaft of a traversing grinder combination. The pivots also carry, on brackets connected by a shaft, a wire toothed burnishing-roller, the bracket having thereon a piece with a curved slot therein, the bracket and roller thus being angularly adjustable around the axis of the disk; a stud and a nut serve to lock the bracket to the disk and a screw limits the downward movement of the roller.

Truing grinding wheels. LANDIS TOOL CO. Brit. 307,477, May 1, 1929. A device for truing two or more grinding wheels of different diameters mounted on a common spindle consists of a base mounted upon the carriage of a grinding machine, and having detachably mounted thereon a slide carrying a plunger adjustably secured thereon by a screw and having an extension carrying a dressing-tool. The plunger has therein a re-

cess having on one face a hardened pin, and a part of the slide carrying a hardened pin projects into the recess. A spring in a bore in the plunger engages the part and urges the plunger toward the grinding wheels. In operation, the tool is brought into contact with the wheel, contact of the pins determining the position of the tool; the wheel is subsequently trued with a gage block between the pins, the gage block being of a thickness equal to the difference of the radii of the wheels. The block consists of two wedge-shaped parts adjustably held together by screws, and held on the part by the flanged head of a screw engaging grooves in the block, and by a pin.

Grinding wheels. R. CHAPELL. Brit. 307,969, May 8, 1929. A grinding wheel has a metal reinforcing ring, rings, or coils embedded therein, arranged concentrically with the wheel, and disposed from 1 to 2 in. from the surface of the central aperture of the wheel.

Centerless grinding machines. V. A. B. HUGHES. Brit. 308,064, May 8, 1929. In centerless grinding machines the work is supported in the grinding throat by a blade and is fed laterally toward the grinding wheel by a yielding regulating wheel until a positive adjustable stop is encountered. Instead of floating in the throat the work is guided by means exterior to the throat so as to form a cylindrical surface concentric with an internal bore or with a previously formed surface on or attached to the work. When operating on a sleeve or bush, the latter is mounted on a mandrel whose ends are engaged by two pairs of rollers rotatable on pins carried by brackets pivoted on spindles, while solid work pieces have their previously machined ends engaging the rollers. The surface of the work being operated upon is supported by a blade, vertically adjustable and locked by screws in a fixed bracket which carries the spindles. The brackets have hoods to protect the rollers from cutting fluid, etc., and are adjusted to position the rollers for determining the final size of the work by screws, one of which engages a fixed stop on the bracket while the other engages a cam rotatable by a hand lever to move the rollers to the work-receiving and cutting positions alternately. Springs assist in removing the rollers from operative position. The regulating wheel may be made of rubber or other yielding material, or its slide may be fed toward the grinding wheel through the medium of springs so as to allow it to accommodate itself to eccentricities in the work and to yield when the work engages the rollers. The work may be removed by an ejector rod actuated from a handle through a lever, or both the ejector and the regulating wheel may be operated automatically.

Centerless grinding machines. V. A. B. HUGHES. Brit. 308,065, May 8, 1929. In a grinding machine having a grinding and a regulating wheel rotating in a plane perpendicular to the path of feed of the work and provided with an interposed work support, work pieces are fed axially along the support and between the wheels by gravity. The machine comprises a base provided with upper and lower horizontal guides on which are mounted slides, the former having bearings for the spindle of a grinding wheel while the latter has bearings for the spindle of an abrasive regulating wheel. Due to the different levels of the guides, the spindles are inclined to the horizontal at an angle, preferably of 30°, and the work support is inclined longitudinally at the same angle while laterally it is inclined downward toward the regulating wheel. A screwed spindle provided with a hand wheel is axially restrained by collars on the base and engages a screwed lug on the slide, and a screwed sleeve provided with a hand wheel is axially restrained by collars and engages a screwed lug on the slide. The work support is mounted in a slot in a carrier, which is laterally adjustable by means of a slot and bolt on a portion of the casing surrounding the wheels, and is adjustable vertically by a wedge. In operation, the wheels are adjusted to the correct distance apart and are rotated in the same direction by belts on pulleys, work pieces placed between guides on the support being thereupon fed by gravity between the wheels.

Centerless grinding machines. V. A. B. HUGHES. Brit. 308,066, May 8, 1929. A centerless grinding machine is adapted for grinding truly cylindrical work or work which is slightly converse or concave on its cylindrical surface. The machine comprises a high-speed grinding wheel and a low-speed regulating wheel which is slightly skewed at a variable angle to feed the work along a support. The wheels are of hard material such as emery. The support has an inclined upper surface, to maintain the work against the regulating wheel by gravity and is provided with a hard steel wearing strip which may be removed, rotated, and replaced to present a new surface to the work when worn. The lower surface of the support is inclined and rests on the inclined surface of a holder adjustably attached to the machine frame by a slot and bolt. Adjustment of the height of the support to accommodate different-sized work is facilitated by graduations on the support and an index mark on a cut-away portion of the holder, the support being a loose fit in the holder and being clamped after adjustment against a flange of the holder by screws passing through inclined slots in the support. The flanges of the holder receive work guides comprising plates, provided with hard steel wearing strips secured by screws. The strips may be reversed to provide four different work-engaging surfaces for each strip when worn. The guide plates are supported on the holder by rounded ends and may be rocked about these ends or about vertical axes by pairs of screws and single screws and clamping screws having rounded necks engaging the plates. For grinding truly cylindrical work the guides are set parallel to the grinding throat while for grinding work which is slightly concave the guides are rocked to the positions whereby the grinding wheel removes more material from the middle of the work than from the ends.

Centerless grinding machines. V. A. B. HUGHES. Brit. 308,091, May 8, 1929. In a centerless grinding machine the work, in its axial passage through the grinding throat, is ground from end to end to a frusto-conical shape, but is reduced to a cylinder of the same size as the smaller end of the frustum as it leaves the throat. The machine comprises a cylindrical grinding wheel and a cylindrical regulating wheel, the former being mounted in bearings on a bracket angularly adjustable about a vertical axis through a boss on a slide and the latter being mounted in bearings on a slide vertically adjustable on a bracket, which is horizontally adjustable on a turntable. The table is angularly adjustable about a vertical axis through a boss on the machine frame. Locking screws are provided for the rotary adjustments and the sliding adjustments are made by hand-operated screws. The work is pushed through the conical throat by a plunger sliding in a sleeve on the machine frame and actuated against a spring by a belt-driven cam acting on a roller projecting from the plunger through a slot in the sleeve. The work support has two cylindrical surfaces corresponding to the diameters of the rough and finished work, respectively, and a central surface which may be frusto-conical or of V-shaped section with tapered sides or having a flat upper surface inclined to the horizontal to suit the conicity of the work.

Art

To what end ceramic engineering? J. H. DULLES ALLEN. *Bull. Amer. Ceram. Soc.*, **8** [5], 99–104 (1929).—A plea from a tile maker is made to the SOCIETY to admit into its councils and to its various collaborations, that thing called beauty which is the soul of ceramics. A. states that design should even supersede engineering research as a final criterion for a piece of ware. The SOCIETY should interest itself more in ceramic art and make the *Journal* a magazine which also contains something of interest to the artist as well as the engineer. E.J.V.

Importance of design to the ceramic industry. J. PALIN THORLEY. *Ceram. Ind.*, **12** [5], 554–55 (1929).—"Design" as applied to ceramics is the rational use of ceramic materials to produce an article which is perfectly fitted to the material out of which it is

formed; fitted for the purpose for which it is intended; and at the same time, satisfying our esthetic emotions. Decorations properly considered should be part of the whole, otherwise expressed, the shape and applied decoration should be complete and complement each other. Foreign competition will be controlled only with sound design and the creation of individual styles. F.P.H.

Industrial art at Metropolitan Museum. ANON. *Glass Ind.*, **10** [4], 91–92 (1929).—A discussion of the Exhibition of American Industrial Art held recently at the Metropolitan Museum of Art is given. This was the first exhibition of the sort by a museum in which everything was of American design and American made. Our designers have no need to go abroad for their design; quality production in American manufactures is on a par with that quantity production for which we are famed. Art museums can do much for the constructive encouragement of art in industry and in daily life. E.J.V.

Prize awards for ceramic art. ANON. *Ceram. Age*, **12** [3], 96 (1929).—A description with photographs is given of prize winning ceramic art specimens exhibited in the 10th Annual Exhibition of the Cleveland Museum of Art. The growing importance of these exhibitions is pointed out. A.E.R.W.

Style and design in selling ceramics. B. MIFFLIN HOOD. *Ceram. Age*, **12** [6], 213–15 (1928).—H.'s address to the Southern Manufacturers' Sales Conference, Atlanta, Ga., is given in full. Choosing fired clay products as typical of ceramic products, H. describes Roman, Norman, English, and American brick and their use in Flemish, English, Dutch, and American bond to give character to a wall and promote sales. H. cites examples to show how and why brick have found favor as the outstanding building material all over the world. As the first step in improving the style and design of roofing tile, the centers of all the continents of the world, except Australia, were visited and styles, compositions, and reasons for using tiles studied. The application of the ideas, so obtained, has increased the demand for roofing tile from 400 to 700% over the prewar period. A.E.R.W.

International Ceramic Exhibition. ANON. *Ceram. Age*, **12** [4], 127–34; [5], 177–80; [6], 216–19 (1928); see also *Ceram. Abs.*, **7** [12], 806 (1928); **8** [1], 9; [6], 388 (1929). A.E.R.W.

Exhibit of contemporary art. ANON. *Crockery & Glass Jour.*, **107** [4], 51–52 (1929); *Int. Studio*, **93** [384], 10 (1929).—One of the most interesting events in the field of modern commercial arts was held recently by Marshall Field & Co., Chicago. Chinaware, glassware, lamps, ceramics, silver, brass, draperies, and other art objects comprised the remarkable collection of the best work of today by the leading decorative artists of France, Austria, Germany, and Sweden. E.P.R.

Modern china versus old china. HESTER RAMSDELL. *Amer. Home*, **2** [3], 328 (1929).—The colorful, interesting pottery and china being produced in American factories and abroad is rivalling the best ceramic products of the world. The types of designs being used and the methods of decoration are described. E.J.V.

New decoration on china and glass. ANON. *Glass Ind.*, **10** [4], 103 (1929); for abstract see *Ceram. Abs.*, **8** [4], 245 (1929). E.J.V.

New light through glass. WYNNA WRIGHT. *Glass Ind.*, **10** [5], 112–13 (1929).—The "Cross" glass, invented by Anson K. Cross, is a drawing and painting glass consisting of a wooden frame $9^3/_8$ x $9^1/_2$ inches in which are set a spirit level, a sheet of plain window glass 6 x 8 inches, backed by a white card and a pair of equal plane-convex lenses about $1^1/_2$ inches in diameter and of about 15-inch focal length. Inserted between the two lower cross-pieces of the frame by means of protective metal bands sliding in grooves, these lenses may be moved at will to right or left. The purpose of the "Cross" glass is to aid one in acquiring true vision of action, proportion, perspective, value, and color. The principle and application of the glass are explained. E.J.V.

Vitrolite for interior decoration. WALTER RENDELL STORY. *Glass Ind.*, **10** [5], 120–21 (1929); *N. Y. Times Mag.*, Feb. 3, 1929.—Vitrolite is an opaque, glasslike substance made by a somewhat different process from glass. It is being produced in colors and ornamented with sand-etched designs touched with color to be used for interior decoration of modern business buildings; also for making furniture, *i.e.*, for coffee and console table tops in the plain white form. Its possibilities as a decorative material are discussed. E.J.V.

Glassware for the new home. MARGARET HARMON. *Amer. Home*, **2** [3], 338 (1929).—Color and texture of modern table glassware now available at small cost are discussed. Italy, Spain, England, France, Holland, Sweden, Germany, and Czechoslovakia are represented, either by their own artistry or by copies which indicate due thought to American requirements in color and form. The types and colors exported by the various countries are discussed, as are the remarkably low prices of most of the ware. E.J.V.

Iridescent glass. J. SIROKY-SIDNEY. *Sprechsaal*, **61** [51], 1004 (1928).—The process of making iridescent glass with a gold effect is described and illustrated. T.W.G.

Colored glasses. W. M. HAMPTON. *Ceram. Ind.*, **12** [5], 539–45 (1929); see also *Ceram. Abs.*, **7** [6], 342; [10], 659 (1928). F.P.H.

Revival of Bohemian glass. ANON. *Nat. Glass Budget*, **44** [49], 7 (1929).—The revival in the glass and jewelry industry in the Jablonec (Gablonz) and Zelezny Brod district of North Bohemia which set in during 1927 made further advance in 1928. E.P.R.

New use for novelty bottles. ANON. *Nat. Glass Budget*, **44** [49], 23 (1929).—Individual bottles for the dressing table are made of black glass in a variety of modernistic shapes embellished with fine metal work in an antique manner set with red and green jewels. E.P.R.

Glaze decoration. J. WOLF. *Sprechsaal*, **61** [45], 883–86; [46], 905–907 (1928).—Composition, manipulation, application, and properties of various foreign and domestic glaze decorations are discussed. T.W.G.

Accurate determination of color. ARTHUR C. HARDY. *Ceram. Ind.*, **12** [5], 580 (1929); for abstract see *Ceram. Abs.*, **8** [2], 88; [3], 168 (1929). F.P.H.

Color in bathroom walls and fixtures. LILIAN BROOKS MORRIS. *Amer. Home*, **2** [1], 29 (1929).—The new trend toward color in bathroom fixtures and tile walls and floors is discussed. E.J.V.

Standard colors in sanitary ware. EDITORIAL. *Glass Ind.*, **10** [5], 122 (1929).—Color standardization for bathroom fixtures and kitchen ware has become a necessity. Manufacturers of sanitary ware must reach an agreement with glassmakers, supplying their needs as to the color to be produced, in order to learn whether or not their color is such that it can be matched. Color must be restricted to a reasonable scale, and must be adopted by the majority of large manufacturers as standard in order to allow glassmakers to go in for mass production. E.J.V.

Ceramic industry in Great Britain. H. TRETHOWAN. *Ceram. Age*, **12** [4], 135–38 (1928).—Notwithstanding the bad trade and unemployment setbacks, the pottery industry is active and, during recent years, has stimulated interest in art by the formation of art schools and exhibitions. The studio pottery has come into the field and hundreds of students attend classes (day and night) in arts and crafts schools. Artists who have become manufacturers are described by T. Sculptured figures are growing in industrial importance. The development, location, constitution, and principal artistic products of (1) Ruskin Pottery, (2) Pilkington's Tile and Pottery Co. Ltd., and (3) Ashtead Potters are described by T. A.E.R.W.

Collecting porcelain and pottery miniature pieces. KATE VILLIERS CLIVE. *Connoisseur*, **83** [333], 285–91 (1929).—Doll pieces are beginning to be sought for and new values placed on them. Wedgwood, Spode, and Rockingham doll sets are described and illustrated. T.W.G.

Wibsey pottery. H. J. M. MALTBY. *Connoisseur*, **83** [332], 217–25 (1929).—History is given of an 18th Century Yorkshire pottery which was situated at Wibsey. The ware which was made is described and illustrated. Production was discontinued in 1830. T.W.G.

Traditional Copenhagen china. ANON. *Crockery & Glass Jour.*, **107** [5], 23–25 (1929).—Work in the Bing & Grondahl studios is without restrictions or restraint. Each artist is at liberty to create whatever he wishes, and color it as he feels inclined. Among the works of art will be found almost every aspect of animal and child life whether of humorous or serious nature. Experiments are being made in artistic stoneware, the most conspicuous of all kinds of ceramics. Eminent artists such as Miss C. Olsen and Gunner Nylund have been secured for this work. E.P.R.

Swedish pottery. ANON. *Ceram. Age*, **12** [3], 113–14 (1928); *Swedish-Amer. Trade Jour.*—The manufacture of clay products in Sweden centers around the basin of Lake Malaren. A heavy layer of calcareous marl, in places 220 ft. thick, occurs above the rock foundations of the extensive Upsala lowlands. The oldest and largest factory exploiting this deposit is the Upsala-Ekeby Co. Complete electrification, modern methods, and a large staff of artists and designers are features of this plant, which manufactures brick, stove tile, pottery, and decorative ceramics. A.E.R.W.

Ceramic statuary of dwarfs and their origin. OTTO POLKA. *Sprechsaal*, **62** [12], 203–209; [13], 219–21 (1929).—P. shows photographs and relates origin of many European dwarf figures. T.W.G.

Austrian ceramics. A. S. LEVETUS. *Ceram. Age*, **12** [6], 221–22 (1928).—L. traces the development of ceramics in Austria to the present industrial growth. A Salsburg stove, made in 1501, an outstanding example of early artistic excellence, is described. The various stages of art as shown in stove tiles is traced through the Baroque Rococo Biedermaier, industrial, and industrial art stages. After a regeneration carried out by means of art schools, design took on a high standard. The career and influence of Michael Powolny are described. Interest in porcelain was revived by the establishment of the Wiener Porzellanfabrik. A.E.R.W.

Porcelain statuettes. ANON. *Arts and Dec.*, **31** [1], 46 (1929).—The earliest known statuettes are Chinese but the later European efforts have more esthetic attraction. A few figures of earthenware, with salt glaze exist and there is an unsolved mystery in connection with some finely-sculptured figures in stoneware by Dwight. The Meissen or Dresden figures excel, mostly decorated in colors, but many in *blanc-de-Chine*. E.B.H.

Ceramic development in Germany. OVE MEYER. *Ceram. Age*, **12** [6], 219–21 (1928).—Germany is one of the centers of the present-day development in industrial art. Industrial centralization and cultural decentralization form an interesting contrast and the basis for a distinctive art. Art schools play an important part. Mass production seems to be the trend at present. M. describes the following producers of ceramic ware: Meissen State Porcelain Manufactory, Nymphenburg State Manufactory, Berlin State Manufactory, Majolica State Manufactory, Alteste Volkstedter Porzellanfabrik, and Oranienburger Werkstatte Korting. A.E.R.W.

French art in the illuminating industry. ANON. *Sprechsaal*, **62** [8], 131–32 (1929).—Seven illuminating objects of various designs are illustrated and described. T.W.G.

The Spanish Expositions. ARTHUR STANLEY RIGGS. *Art and Arch.*, **27** [4], 147–64 (1929).—Interesting to ceramists will be the exposition at Seville for its display of ma-

jolicas, decorative tiles, and ceramics of all sorts used in balustrades and pavilions; also the city's permanent exhibitions such as the Convent of Santa Paula famed for its marvels of tiling and mosaic, and the busy ceramic manufacturing district of Triana. At Barcelona the gem of the exposition is the fountain. Here also the first international light fair ever held will trace the evolution of illumination. E.B.H.

Ancient inhabitants of Utah. LEVI E. YOUNG. *Art and Arch.*, **27** [3], 125–35 (1929).—Splendid specimens of pottery have been found at San Juan and other sites in Utah, evidence of a bygone race who have left no literature and no art except that expressed in their pottery. Coiled and black and white pottery are the prevalent types. The coiled ware, though the most primitive, is well made with the coils neatly indented. Illustrated. E.B.H.

Art work in the Indian schools. NELLIE HAGAN. *Design*, **31** [1], 18–20 (1929).—Modern pottery is closely related to the art of the American Indian. An inherent artistic instinct shows in the work of the children of certain tribes in reservation schools and effort is made not to disturb their heritage. Their design is naturally symbolic; in the use of color red means blood or war; yellow, the sun; green, water, grass or trees; brown, the earth; white, life or light; and black, death or sorrow. Bowls are built free-hand starting with a ball of clay which is worked into a saucer shape, the base of all Indian pottery. The coil method completes the sides when the pottery is allowed to dry ready for refining with sand paper and polishing with a smooth stone. The decoration is painted on freely upon a layer of thin white clay covering the bowl. To fire, the bowls are grouped on a smooth rock surface surrounded and covered with tinder. The pile is lighted in several places and more fuel added as needed. This achieves a finely baked appearance. E.B.H.

English Delft. I. 17th Century. FRANK DAVIS. *Illus. London News*, **174**, 636 (1929).—A type of pottery of exceptional decorative value is the rather coarse earthenware covered with an opaque tin glaze, the process for which was brought to England by Italian emigrants from Antwerp. The ware is the production of humble people, who were successful in spite of the crudity of design and technique of their work. Illustrated. H.H.S.

English Delft. II. Michael Edkins and the Bristol potters. FRANK DAVIS. *Illus. London News*, **174**, 726 (1929).—Through the researches and excavations of the late W. I. Pountney, a good deal is known about the Bristol potters of the 18th Century, and their products. Bowen, Joseph Flower, and John Niglett were the most productive. Edkins came to Bristol as an artist from Birmingham. Five illustrations of his plates, done for Flower, are given. H.H.S.

Chelsea porcelain. ANON. *Illus. London News*, **174**, 696 (1929).—An account is given of the English descendant of the ware which Böttger produced at Meissen while engaged on the alchemist's search of turning base metal into gold. Sprimont, who succeeded Gouyn as proprietor of the Chelsea factory, is said to have been financed by that Duke of Cumberland who is known in history as "the butcher of Culloden." Illustrated. H.H.S.

The Portland vase. ROGER HINKS. *Int. Studio*, **93** [384], 33–36 (1929). J. S. WILLIAMS-THOMAS. *Pottery Gaz.*, **54** [622], 640 (1929). ANON. *Pottery Gaz.*, **54** [623], 783–86 (1929). See also *Ceram. Abs.*, **8** [6] 390 (1929).

15th Century stained glass window. V. GRANCSAY. *Bull. Met. Mus. Art*, **23** [11], 268–71 (1928).—A recent addition is a stained glass window of the Angevin school of the late 15th Century, which represents Saint Michael and a Donor, who was a knight of the King's Order. It comes from a chapel near Angers. King René of Anjou, who was actively interested in armor and military sports, also made stained glass. In most countries of Europe local schools of glass-painting flourished, each

with definite characteristics. A typical canopy window of the perpendicular style, one of a triptych, of white glass of a dusky tint produced by stippling, is enriched by yellow stain. Great heat was essential to fuse materials and remove impurities. A.A.A.

Two 14th Century stained glass panels. JAMES RORIMER. *Bull. Met. Mus. Art*, **23** [11], 271–74 (1928).—The Museum has recently added two panels of French 14th Century stained glass to its collection of medieval art. The two windows, containing representations of the Prophet Isaiah and Saint Mary Magdalen enshrined in architectural niches, are from the same series. Above and below the central figures are sections decorated with a geometric design in grisaille of the same period, which may or may not have belonged to the original windows. Stained glass is one of the most fascinating arts of the Middle Ages. Small pieces of variously colored glass were held together by the thin lead strips which enframed them. Details and delineations were usually painted upon the inner side of translucent glass with enamel colors which were afterward fired into the surface of the glass leaving it more or less transparent. French stained glass of the 14th Century is usually considered inferior to that of the great periods in the 12th and 13th. A decorative quality due to pure design was sacrificed for representation. The colors were less brilliant and there was an extensive use of white or tinted glass. The two panels considered in this article illustrate the best traditions of the earlier work in the figures and their backgrounds. The architectural details in relation to their backgrounds are not as good. Glass painted in grisaille was less expensive and more translucent than stained glass. It was often used in combination with stained glass, as in these panels. They may be assigned to the first half of the 14th century. They resemble closely the glass of the cathedral of Evreux, considered to be the finest example of 14th Century glass. A.A.A.

A Greek bobbin. GISELA M. A. RICHTER. *Bull. Met. Mus. Art*, **23** [12], 303–306 (1928).—A spool consisting of two terra cotta disks about five inches in diameter joined by a narrow cylinder was recently acquired. The outer sides of the two disks have painted decorations in polychrome on a white ground. One side is complete and Eos, the goddess of dawn, and the Athenian hunter Kephalos are represented. In the other scene a winged youth is pursuing another youth who holds a lyre. These pictures are distinguished from fine vase painting by a grandeur of conception which lifts them from the decorative plane to that of the higher arts. They are the work of a dramatically imaginative man. His real name is unknown but he was the so-called Penthesileia painter (about 460–450 B. C.). The object is supposed to be a spool or bobbin, made for some special occasion. The common material used for such spools was wood. Only two similar examples are known, both of them in Athens, but such spools have been found in Egypt made of wood, limestone, and even terra cotta. A.A.A.

A pair of Greek satyr vases. GISELA M. A. RICHTER. *Bull. Met. Mus. Art*, **24** [3], 81–83 (1929).—Two remarkable Greek plastic vases are recent acquisitions. They are each in the form of a squatting satyr with one arm placed round a large funnel-shaped vase by his side. A panther's skin is draped loosely on his back and arms, leaving the front part of the body nude. These two vases are a new type, no others like them having been preserved. Only one of the pieces is complete and it is an important new example of Greek sculpture in terra cotta, belonging to the height of the development of Greek sculpture. A similar crouching satyr occurs on the coins of Naxos of about 461–413 B. C. Each figure was pressed in a mold and is hollow. The vase itself could have served to hold liquids. The vases were glazed in an attractive polychrome scheme of black, red, yellow, and white. These vases could hardly have been intended for drinking purposes as other Greek plastic vases were, for they are heavy and have no handles, and would hold very little. They were probably intended for some ceremonial use. A.A.A.

Excavations in Italy and Sicily. THOMAS ASHBY. *Illust. London News*, **174,** 705–707 (1929).—Besides the Fascist Government's excavations, the Papal Commission for Christian Archaeology and a number of other bodies have been busy in Rome, in the provinces, and in Sicily. Fifteen photographs, including clay vases of the 4th Century B. C. modelled as dappled hound and stag are included. H.H.S.

Prehistoric pottery at Malta. ANON. *Nature*, **123,** 257 (1929).—A number of potsherds have been unearthed near Porta Reale, Valletta. The ware was coated with red slip on which were elaborate white line decorations done with a brush. It is considered a survival of a prehistoric industry. C.R.A.

Neolithic Fayun pottery. G. CATON-THOMPSON. *Nature*, **123,** 470 (1929).—An account is given of the neolithic pottery of the Fayun. C.R.A.

Antique pottery. M. SCHEFOLD. *Sprechsaal*, **61** [44], 866–69 (1928).—The Stuttgart Museum has acquired some old ceramic art objects: decorated pitchers, candle sticks, tureens, and statuary. Illustrated. T.W.G.

Etruscan art. HANS MÜHLESTEIN. *Atlantis*, **1,** 182–84 (1929).—Reproductions plain and in color of early examples of Etruscan art are said to have been formed by the successive influences of Asia Minor, Asia, Greece, and Italy. H.H.S.

Giacomo Boni, excavator. O. L. RICHMOND. *Blackwood's Mag.*, **225,** 524–29 (1929).—Memories of the well-known Italian archaeologist. H.H.S.

Liddell collection of old Chinese porcelain. ANON. *Illust. London News*, **174,** 690 (1929).—The collection by Oswald Liddell at the Bluett Galleries is contemporaneous with the Salting collection at the Victoria and Albert Museum. Illustrated is a piece of Ming ware, remarkable as a Chinese figure with a face that shows an outstanding Indian feeling. H.H.S.

Chinese pottery and porcelain. FRANK DAVIS. *Illust. London News*, **174,** 690 (1929).—Exportations of Chinese ware during the last three centuries have been those of pieces either expressly made for the Western taste or not of sufficient quality to attract Chinese connoisseurs. The position today is different. We are able to see the whole development of the art in which the Chinese have been pre-eminent from the beginning. The most important periods are those named T'ang, Sung, Ming, and Ching. Illustrated. H.H.S.

A group of Chinese tomb figurines. ALAN R. PRIEST. *Bull. Met. Mus. Art.*, **23** [11], 264–66 (1928).—Nine Chinese tomb figurines of the Six Dynasties on exhibition in the Room of Recent Accessions, represent dancers, ladies-in-waiting, and male and female servants, and were made for the service and entertainment of the dead. Five of these figures are made of black clay; the other four, dancers, are made of red clay and seem to have been modeled by hand, with the possible exception of the heads. All are unglazed. In freedom of movement and in costume, they seem closer to the potteries attributed to the T'ang period than to any of the potteries so far ascribed to the Six Dynasties, or the Wei period. A.A.A.

Chinese roof decorations. GENEVIEVE B. WIMSATT. *Art and Arch.*, **27** [4], 175–85 (1929).—The faïence animals and grotesques on Chinese roofs are not accidental but according to well-prescribed law for definite purposes as protection, etc. Most interesting are the roof dogs or "stars of the house" at the corners of gables led invariably by the "spirit of the sun star" mounted on a golden-feathered cock which regulates the rising and setting of the sun. E.B.H.

Future of the small plant. THEODORE LENCHNER. *Ceram. Age*, **12** [3], 89 (1928).—The small plant has a profitable future in view provided the executives are far-sighted and capitalize the growing interest in ceramic art. A.E.R.W.

Leigh ware. ALDEN WELLES. *Crockery & Glass Jour.*, **107** [4], 27 (1929).—A distinct innovation in American dinner and art ware is embodied in the product of Leigh

Potters, Inc., of Alliance, Ohio. The body is designated "Umbertone," emphasizing a distinctive ivory hue of body. E.P.R.

Art pottery plant. ANON. *Crockery & Glass Jour.*, **107** [5], 51 (1929).—East Liverpool will probably be the location of one of the largest art pottery plants in the country. E.P.R.

New china patterns. ANON. *Crockery & Glass Jour.*, **107** [5], 51 (1929).—A number of new patterns are featured by Edwin M. Knowles China Co., on their new Roslyn shape. E.P.R.

New shape in china. ANON. *Crockery & Glass Jour.*, **107** [5], 52 (1929).—The Albright China Co., Carrollton, Ohio, is now featuring "Albright Amber" on its Pilgrim shape, and will add another shape, "Futuro," designed along modernistic lines. E.P.R.

BOOK

Victoria and Albert Museum Picture Books. ANON. H. M. Stationery Office, London. 6*d*. each (post free, 7*d*. each). The series of picture books issued by the Victoria and Albert Museum now numbers thirty-eight, the last dealing with Turkish pottery. These picture books consist mainly of admirably produced illustrations of specimens of the ware which is discussed in a short introduction. The series covers all kinds of works of art, but the following are particularly interesting: (2) English porcelain figures, (7) English glass, (15) Persian pottery, (26) Wedgwood ware, (29) English mirrors, (33) Chinese pottery figures, (38) Turkish pottery. Reviewed in *Pottery Gaz.*, **54** [623], 755 (1929). E.J.V.

PATENTS

Design for a plate. BRUCE THORNGATE. U. S. 78,415, April 30, 1929; ULRICH HAGMANN. U. S. 78,466, May 7, 1929; JOHN EDWARD GOODWIN. U. S. 78,515, May 14, 1929.

Design for a dish. CHARLES H. WEST. U. S. 78,370, April 23, 1929; JOHN V. GODDARD. U. S. 78,283, April 16, 1929.

Design for a goblet. JAMES DUNCAN DITHRIDGE. U. S. 78,507, May 14, 1929.

Design for a bottle. JOSEPH R. ROUTT. U. S. 78,314, April 16, 1929; CHARLES L. GRIGG. U. S. 78,351, April 23, 1929; FRANK D. COSTER. U. S. 78,448, May 7, 1929; WALTER E. GRONIGER. U. S. 78,465, May 7, 1929; FRANK R. MILLER. U. S. 78,479, May 7, 1929; JACOB GOLDHABER. U. S. 78,514, May 14, 1929.

Design for a lavatory. JAMES M. BONNER, JR. U. S. 78,257, April 16, 1929.

Design for a fountain. GEORGE S. BRUSH. U. S. 78,265, April 16, 1929.

Design for a fireplace. JONAS G. JOHNSON. U. S. 78,355, April 23, 1929.

Design for a fluted column. VAHAN HAGOPIAN. U. S. 78,286, April 16, 1929.

Cement, Lime, and Plaster

New soundness test for lime. ANON. Bur. Stand., *Tech. News Bull.*, No. 144, p. 34 (1929).—A new method for testing unsoundness of lime plasters has been developed. The lime, which is to be tested, either quick or hydrated, is made into a putty by addition of water. One part of gaging plaster is added to 2 parts of the lime putty, and after thorough mixing the paste is spread in a thin layer on an absorbent plate. The plate is then allowed to remain undisturbed for about 1 hr., or until the paste has set. It is then placed in an autoclave and steamed for 2 hrs. at a steam pressure from 20 to 25 lbs./sq. in. Unsoundness of the cooled specimen is evidenced by popping, pitting, or cracking of the plaster. This test may be completed in 4 hrs. or less. R.A.H.

New wet-process cement plant. CHARLES G. THORNBURGH. *Cement, Mill & Quarry*, **34** [5], 13–17 (1929).—A combination of three allied industries is now under construction; a by-product coke plant, a blast furnace, and a wet-process cement

plant. The coke-oven plant will furnish gas for the cement kilns, coke to the blast furnaces, and coke breeze for fuel at the main boiler house. The blast-furnace plant will supply the cement plant with granulated slag and the main boiler plant with gas. Surplus power will go to Duquesne Light Co., through a sub-station located on the property. E.P.R.

Development of modern kiln design. E. L. JOHNSON. *Cement, Mill & Quarry*, **34** [5], 45–47 (1929).—J. gives in detail the requirements met. E.P.R.

French hydraulic refractory cement. ANON. *Refrac. Jour.*, **4** [43], 228 (1929); *Arnould Chaleur et Ind.*, p. 536 (1928); *Building Sci. Abs.*, Dec., 1928.—A proprietary refractory hydraulic cement of French origin is described. This alumina cement is of the slow-setting, rapid-hardening type, is non-friable and has softening and fusing points up to 1400 and 1500°, respectively. An economical fire-resisting concrete produced with this cement and refractory aggregate is suitable for all kinds of refractory structures which can be cast *in situ*. E.P.R.

Protection of concrete against corrosion. C. R. PLATZMANN. *Chem. and Ind.*, **48**, 369 (1929).—Cements low in lime have greatest resistance to corrosion by acid and salt solutions. High Al_2O_3 confers resistance but is more expensive. Concrete may be protected by a surface coating of tannic, lactic, or acetic acids, or by silico-fluorides, but most satisfactorily (apart from the softening at increase of temperature) by bitumen. In general, the best method of protection has to be determined for each case. H.H.S.

Rationalization of shaft lime-kiln design. VICTOR J. AZBE. *Rock Prod.*, **32** [8], 56–60 (1929).—A. develops a basis for comparison of kiln performance. F.P.H.

Effect of aging on grinding resistance and cementing value of Portland cement clinker. L. N. BRYANT. *Rock Prod.*, **32** [8], 64–65 (1929).—A low-lime clinker will lose less of its cementing value on being aged than will a high-lime clinker. When clinker is to be stored in the open a low-lime clinker will result in higher ultimate tensile strength. Tests do not agree with the old opinion that aging of sound clinker produces a higher quality cement. Grinding resistance increases with the increase in loss on ignition. When Portland cement clinker is subjected to weathering, calcium hydroxide crystals and crystalline compounds of lower lime content form a more elastic clinker and subsequently raise the tensile strength within itself, due to the higher elastic limit of the calcium hydroxide crystals. F.P.H.

Heat transfer in rotary kiln burning Portland cement clinker. ROBERT D. PIKE. *Rock Prod.*, **32** [9], 60–63 (1929). F.P.H.

Solubility of slags in citric acid. H. SCHNEIDERHÖHN. *Stahl und Eisen*, **49** [11], 345–52 (1929).—The microscopic composition and structure of various treated Thomas slags and their relation to the solubility of the slags in citric acid are given. F.P.H.

Variable hardening of Portland cements. MAX GENSBAUR. *Tonind. Ztg.*, **52** [99], 1976–77 (1928); *Rock Prod.*, **32** [8], 96 (1929).—G. replies to H. Kühl's article on this subject (*Tonind. Ztg.*, No. 43 (1928); for abstract see *Ceram Abs.*, **8** [1], 8 (1928)). In addition to his theories on the action of clinker in storage he states that Portland cement clinker with free lime may be made entirely consistent in volume to a certain degree by boiling and leaching in water. Thus far there is no direction concerning the period of storage of clinker or of the period of storage of cement in bins. F.P.H.

Chemical resistance ability of cement. CURT PRUESSING AND R. GRUEN. *Zement*, **17** [26], 1006–1007 (1928); *Rock Prod.*, **32** [8], 96 (1929).—A controversy between P. and G., in which the latter states that the subject of the controversy is the question of whether it is possible to make a salt-water-resistive cement out of iron-ore cement by grinding this iron-ore cement with blast-furnace slag. G. maintains the affirmative and P. the negative. F.P.H.

Cracking of glass plates by standard-cement samples. F. SCOTT. *Zement*, **17** [30], 1134–37; [31], 1169–72 (1928); *Rock Prod.*, **32** [9], 78 (1929).—S. gives the results of his investigations on the causes of the cracking of glass plates when standard cement samples, particularly in water storage, adhere to them. The results of many varied tests with different cements and different grades of glass are described and illustrated. F.P.H.

Bauxite cements. W. OBST. *Zement*, **18** [4], 98–99 (1929); *Rock Prod.*, **32** [9], 78 (1929).—O. reviews the literature respective to the history of bauxite for cement production, some processes of making bauxite cement and various plans for the utilization of bauxite. F.P.H.

Water glass as cement admixture. R. GRUEN. *Zement*, **18** [7], 192–94 (1929); *Rock Prod.*, **32** [8], 96 (1929).—G. reports from the research institute of the German cement industry that occasionally the admixture of water glass to the makeup water of mortars has proved suitable for accelerating the setting period. A Portland cement and an iron cement were tested, the test batters being stored in water, magnesium sulphate, acetic acid, and in linseed oil. The test data showed that the course of hardening of the two cements is influenced but little by the water-glass admixture and in general there is a slight decrease in strength. When storing the test batters in magnesium sulphate solution, aggression on the Portland cement was not stopped by the admixing of water glass; on the contrary, the dissolved water glass was unfavorable in that it accelerated the aggression. Iron cement without admixture of water glass showed no decrease in strength; and with admixture of water glass showed an initial decrease of strength, but regained this loss later. The water glass did not increase resistibility to acetic acid; and when admixed to iron cement and stored in linseed oil, the results were unfavorable, the cements without admixture of water glass keeping better. When making the cements into concrete, a difference in the imperviousness to water could not be determined. These results tally completely with those of Haegermann (see *Zement*, p. 795 (1925)). Resistance to salt water decreased more when using dissolved water glass than when using raw water glass. It is therefore not recommended to add powdered water glass to the mortar. F.P.H.

Portland cement in Canada. W. A. TOOHEY. *Trans. Can. Inst. Min. and Met.*, **30**, 357–89 (1927).—The following subjects are discussed: (1) history of the Portland cement industry in Canada, (2) production and consumption of cement in Canada, (3) modern practice in the use of cement, (4) uses of Portland cement concrete, and (5) advantages of concrete construction. F.P.H.

Italian cement standards. ANON. *Tonind. Ztg.*, **52** [66], 1348–49 (1928); *Zement*, **17** [34], 1273–74 (1928); *Rock Prod.*, **32** [8], 96 (1929).—The Italian cement standards, which became effective on September 6, 1927, were replaced with new standards on June 7, 1928. The distinction between natural cement and artificial or Portland cement has been stressed further; and the distinction between high-grade and trade cements (cements of first and second quality) has been dropped; in its stead the minimum compressive strength of standard mortar of 1:3 proportion after 28-day water storage has been raised from 250 kg. per sq. cm. (3556 lb. per sq. in.) to 280 kg. per sq. cm. (3983 lb. per sq. in.). The directions for the preparation of test samples and for testing and those for supervision of the cement plants remain unchanged. F.P.H.

Idaho cement company erect plant. ANON. *Cement, Mill & Quarry*, **34** [5], 44 (1929).—Idaho Portland Cement Co. is erecting a $500,000 plant at Inkom. E.P.R.

Penn-Dixie takes over the Pyramid Co. ANON. *Cement, Mill & Quarry*, **34** [5], 17 (1929).—The Pennsylvania Dixie Cement Corp. has acquired the business

and property of the Pyramid Portland Cement Co. of Delaware. The cement is under the brand "Penn-Dixie." E.P.R.

Cement plant at Ketton, England. ANON. *Chem. News*, **138**, 268 (1929).—A new plant capable of manufacturing 60,000 T. of high-grade Portland cement commences operation July, 1929, at Ketton, Rutland. H.H.S.

Bauxite cement works for Czechoslovakia. ANON. *Cement, Mill & Quarry*, **34** [5], 34 (1929).—Negotiations are in progress for the erection of a bauxite-cement works 60,000 to 80,000 T. capacity in Czechoslovakia. E.P.R.

New process for burning Portland cement. KARL BEHL. *Cement, Mill & Quarry*, **34** [5], 40–42 (1929).—A new shaft kiln was recently made available by the Andreas G.m.b.H., of Muenster, Westphalia. No sticking or hanging of the charge, almost complete elimination of underburning, increase of output by 100%, an improvement in the quality of the cement, and ordinary power and fuel consumption are the chief advantages of the new process. E.P.R.

PATENTS

Manufacture of hydraulic cement. ROBERT DE LUCE. U. S. 1,713,172, May 14, 1929. Process for the production of hydraulic cement which comprises digesting an aqueous mixture comprising lime, silica, and alumina in proportions suitable for the production of Portland cement at a temperature of at least 100°C under superatmospheric pressure and with violent agitation until the lime, silica, and alumina are combined as an insoluble calcium aluminium silicate, and heating the insoluble calcium aluminium silicate to the point at which fusion first becomes apparent.

Hydraulic cement composition. LENNART FORSÉN. U. S. 1,712,818, May 14, 1929. Process of producing hydraulic cement compositions which comprises the steps of adding a granular extender as well as burnt lime to ordinary Portland cement, subjecting the mixture of materials to grinding, and continuing this grinding for a sufficiently long period of time to convert the Portland cement constituent into a product of sufficiently fine degree of subdivision to be able to react quantitatively with water.

Lime and cement furnaces. A. C. DAVIS. Brit. 307,763, May 8, 1929. In the manufacture of lime and cement the raw materials in slurry or powdered form are injected into a shaft through nozzles at the base, and pass upward and downward through a combustion zone which is formed in a substantially horizontal plane by oil, coal, or other burners. By adjusting the velocity of projection in relation to the state of subdivision of the raw materials the particles can be kept in suspension until clinker is formed. Supplementary air, preferably heated by contact with the discharged clinker, may be delivered to the upper part of the shaft to agitate the suspended particles. The burners are arranged in two opposed pairs with the jets for the slurry, etc., between the pairs and at a little lower level, and the angle at which the slurry, etc., is injected may be varied by adjusting the jets. The waste gases may be withdrawn from the furnace by a fan, and may be utilized together with air, heated by the discharged clinker, for heating a boiler. In a modification a single horizontally-arranged burner delivers tangentially into the shaft.

Making mixed cements. G. HAEGERMANN. Ger. 464,175; *Rock Prod.*, **32** [8], 97 (1929).—Alumina cement can be mixed with mortar binders containing silicic acid to obtain a high-grade cement. Alumina cement fixes the free lime of Portland cement. Any other mortar binder may take the place of the Portland cement such as precipitated silicic acid, silica substances, kieselguhr (diatomaceous earth), trass, pozzuolanas, tufas of all kinds, pumice stone, ashes, and slags of every source, fired clay, oxalic acid or other weak acids or weak acidulous salts. One form of the mixed cement would consist of alumina cement, blast-furnace slag of some kind, and a lime-fixing admixture. F.P.H.

Granulating fused blast-furnace slag. ANON. Ger. 465,084; *Rock Prod.*, **32** [8], 96–97 (1929).—A horizontally located rotating conical drum provided with steel balls in the manner of the well-known ball mills, is supplied at the open face with a flow of slag and water. Quenching is aided by grinding and the Leidenfrost phenomena is eliminated. Slag sponge is prevented, hence the slag absorbs but little water and cools slowly. By control all water supplied may be evaporated, so the slag discharges completely dry and well sized. F.P.H.

Enamels

Properties of simple enamel glasses. A. I. ANDREWS. *Jour. Amer. Ceram. Soc.*, **12** [6], 390–94 (1929).—Three component glasses of the systems Na_2O–B_2O_3–SiO_2 and Na_2O–PbO–SiO_2 were investigated as to acid-resisting properties. An increase in silica in general improves the acid resistance. The effect of Na_2O, B_2O_3, and PbO on the acid resistance of an enamel is dependent on the composition to which these oxides are added. Some of these enamels showed considerable promise as acid-proof enamels.

Cast-iron enameled ware. J. B. NEALEY. *Ceram. Age*, **12** [6], 223–24 (1928).—N. describes the enamelware plant of the Richmond Radiator Co., Uniontown, Pa. The product is moved in a straight line. (1) *Foundry:* The storage spaces for raw materials are arranged in line with the cupola-charging platform. A continuous molding unit of the oval track type includes a jolt-type mold machine, a cupola, and a shake-out station. (2) *Enameling Dept.:* A slush coat is poured over the castings and allowed to dry. The ware is then heated in gas-fired furnaces of brick construction operating around 1700 to 1750°F. It is removed from the furnace and placed on an enameling table, where enamel powder is applied by a sieve with an attached air vibrator. The tub is then returned to the furnace. Two or three coats of powder are applied. The tubs are cooled in individual cooling ovens. A coat of paint is sprayed on the outside. The enamel batch is melted in gas-fired furnaces operating at 2250°F, about 3 hrs. being required, and is tapped into clean water to form frit. The frit is dried in a gas-heated rotary drier, ground in 5 ft. pebble mills, sifted, and placed in sheet-iron containers. In grinding the slush coat, water and other ingredients are added at the mill. A.E.R.W.

Invisible oxide films on metals. F. H. CONSTABLE. *Nature*, **123**, 569 (1929).—It is found impossible to expose surfaces of iron, nickel, and copper to the air without the formation of invisible oxide coatings. C.R.A.

Removing iron from enamel frit with magnetic separator. ANON. *Ceram. Ind.*, **12** [5], 556–57 (1929).—A magnetic separator removes iron particles from the frit and also particles containing metallic iron. From the rotary drier, the frit is elevated by a bucket elevator to a screen to remove all particles over $^1/_2$ in. This belt conveyer is approximately 12 ft. long and built at an angle of about 15° with the horizontal. The speed of this belt is approximately 68 ft. per min. In front of the large screen hopper is a large magnet. A double magnetic plate is used so that material not picked up by the first plate will surely be removed by the second. The frit is absolutely dry before passing the magnet. F.P.H.

Use of white ground coat in modern enameling practice. ANON. *Ceram. Ind.*, **12** [5], 558–59 (1929).—This particular type of ground coat was used successfully in Germany 20 years ago. During the last 2 yrs., a considerable amount of work has been done in order to obtain a durable, adhesive, white ground coat, and to supply the necessary adhesiveness, cobaltic and nickelic solutions have been tried. In some instances rare earth oxides have been used, but the latter seem to have a contrary effect. When no black or deep blue is required, the white ground coat seems to give a brighter

hue to the covering color. It is necessary in using a white ground coat when such colors are employed, to be sure that the ground coat will not flux sufficiently with the covering color to show through, as it is said that the covering color will appear to be rather washed out if the white cover coat, which is used, fluxes readily with the white ground. In an experiment on a light-colored cobalt base sheet-steel enamel, Heimann recommends the following composition:

No. 1		No. 2	
Borax	32	Borax	3.5
Feldspar	34	Quartz	8.0
Quartz	10	Feldspar	1.5
Soda ash	7.2	Soda ash	0.5
Fluorspar	4.5	Bone ash	0.5
Soda saltpeter	1.2		
Cobalt oxide	0.5		
Nickel oxide	0.3		

Mill: 74 parts No. 1; 26 parts No. 2; 7 parts clay.

F.P.H.

New G.E. furnaces have elevated heated portion. ANON. *Ceram. Ind.*, **12** [5], 580 (1929).—A new type of continuous conveyer furnace, designed for vitreous enameling service and marketed by the General Electric Co., utilizes electric heat and is very economical in operation. The unusual economies claimed are the result of two important features of design: (1) utilization of the so-called closed-end construction, and (2) elevation of the heated portion of the furnace. In the closed-end type of construction the furnace is built U-shaped. The work enters and leaves by the same end, and the heating units are installed at the closed end. Thus the heat is concentrated in the latter part of the furnace being utilized as a heat-interchange chamber (the incoming cold work is dried and preheated in this neutral portion by the outgoing heated work). The other improved construction feature is the elevation of the heated zone above the level of the remainder of the furnace, thus trapping the heated air in the closed end of furnace and eliminating the conduction losses found in the common type of horizontal furnace. F.P.H.

Studies in metal crystal orientation. I. Determination of orientation of metallic single-crystal specimens by high-voltage X-rays. THOMAS A. WILSON. *Min. and Met.*, **10** [269], 251 (1929).—In the research laboratory of the General Electric Co., the Laue method of analysis by X-ray has been used for determining the interior orientation of crystals of silicon steel. W. describes the apparatus employed to obtain photographs and the solution of these either by applying gnomonic projection alone or by applying the stereographic-gnomonic double net. F.P.H.

Whiteheart malleable tests. E. R. TAYLOR. *Bull. Brit. Cast Iron Res. Assn.*, **22**, 55–58 (1928).—The testing of malleable castings is discussed, with special reference to the size of test-bars for thin-walled castings. (*J.I.S.I.*)

Composition of enamel. ANON. *L'Email*, **1** [2], 4–6; [3], 8–9 (1929).—This series of articles deals with the coefficients of expansion, elasticity, tension problems, resistance to pressure and abrasion, and fusibility of enamels. T. W. G.

Dust. ANON. *Emaillewaren-Ind.*, **6** [9], 69 (1929).—Not all dust in enameling plants is avoidable. Organic dust particles, especially wood and leather, coming in contact with hot enamel will burn leaving a white ash which will often cause a dark speck. Most black specks are caused by dust containing iron. Embedded organic dust may take its oxygen for combustion from the enamel and blisters may result. Quartzitic dust is usually not harmful. Most dust is derived from the top of furnaces and from the floors. It is advisable to carry the furnace walls to the ceiling by sheet metal, using the air from this concealed space for drying. A monolithic floor without

joints is best and any sawdust used for cleaning, should have its fines screened out. The use of a dust collector is advisable. T.W.G.

Misuse of word "enamel." ANON. *Emaillewaren-Ind.*, **6** [10], 75–76 (1929).—The difference between lacquer and enamel is emphasized and it is pointed out that the term "enamel" is often used in the wrong place and that enamelers should guard this term from misuse. T.W.G.

Manufacture of enamelware. ANON. *Emaillewaren-Ind.*, **6** [10], 77–78 (1929).—It is the concluding installation of the series dealing with decorating. For previous abstract see *Ceram. Abs.*, **8** [5], 324 (1929). T.W.G.

Enameling stove parts. ANON. *Emaillewaren-Ind.*, **6** [11], 83–84; **6** [12], 91–92 (1929).—Flat objects requiring a white enamel on one side only are discussed. To avoid warping, the metal should be heavier than the enamel, and the thickness of the plate should increase with its size. The enamel should have the greatest possible coefficient of expansion and low fusion point, although low expansion would give greater resistance to temperature changes. At this point warping may be corrected. The ground enamel must fully cover the outer side; blisters have to be opened by a center punch applied to the rear of the plate, and the outer side is repaired by brushing and refiring. Any white enamel that might get onto the underside is sponged off. If the enamel is not cleaned off before firing the tightening of the screws during erection of the stove will cause the enamel to crack. Greater production is obtained by firing the objects suspended. T.W.G.

Avoiding defects in ware. W. LINKE. *Emaillewaren-Ind.*, **6** [12], 92–94 (1929).—Numerous practical points are given in the making of cooking utensils, pitchers, etc., to obtain flawless ware. T.W.G.

Manufacture of enameled signs. ANON. *Emaillewaren-Ind.*, **6** [16], 125–27 (1929).—There are two groups of signs: (1) single signs of various designs, and (2) signs of identical design obtained by mass production. The shapes are pickled and the ground enamel is applied by dipping followed by the first coating which usually is white. Small signs are often produced with a brilliant enameling powder. After cleaning by turpentine, such powder is applied by a sieve and the sign is fired. Mass production of small signs is similar since powdering is quicker than wet application. Spraying the enamel is also advantageous. After the last firing the signs must be straightened. The lettering is important. Single signs with black letters are painted with a brush. On larger signs the letters are outlined in wax crayon and filled in. If lettering is to be repeated, alphabets are made on stone, aluminum, steel, or zinc. The single letters printed on tissue paper, are cut out and placed on the sign, and then filled out. Small type of regular printing size is usually set in printing type and printed by press with ceramic color on a rubber plate. From here the print is taken off by means of a tissue paper and transferred to the sign. If there are very many signs with uniform large text, templates and brushes are employed. The sign is fully covered by the lettering enamel and dried. Two templates are used with the letter links in different places. The first template is placed on the sign and the enamel brushed off from the open places of the template, then the second template is applied eliminating the letter links of the first. All that is to remain has to be fully covered by the templates. This method is suitable not alone for letters but also for colored surfaces. Firing has to be done usually after each color application. The more colors used, the oftener the signs must be fired. T.W.G.

Fluorine in enamels. ANON. *Emaillewaren-Ind.*, **6** [13], 103 (1929). T.W.G.

Origin of colored or marbled enamels. ANON. *Emaillewaren-Ind.*, **6** [13], 101–103 (1929). T.W.G.

Development of enamel composition. ANON. *Emaillewaren-Ind.*, **6** [17], 137–38

(1929).—In 1782 Rinman experimented with the first enamels. The history in the development of a suitable enamel composition is described. T.W.G.

Production of high-duty cast iron and its metallurgical principles. B. OSANN. *Die Giesserei*, **15,** 648–55 (1928).—O. points out that all special iron processes really aim at producing an all-eutectic structure and finely-divided graphite. The refinement of the latter is brought about by the suitable adjustment of the carbon and silicon, by superheating the metal, or by jolting. O. discusses the metallurgy of the processes; he deals at length with the superheating process, and asks whether the same result cannot be obtained less expensively. His answer in the affirmative turns on the difference between solid solution carbon and kish. Hanemann attributes the presence of coarse graphite to the precipitation of carbon on nuclei; O. considers these nuclei to be the kish, which in the ordinary melting of pig iron is not removed and remains in the metal when it is cast. The kish is removed, however, in the superheating process, not by virtue of the high temperature according to O., but because the longer time permits it to burn off or be removed in the slag; in the jolting process it is removed mechanically to the surface, where it meets the slag. The raw material requirements, then, for a high-duty iron are a kish-free metal of eutectic composition, and from this point of view the coke and charcoal blast-furnace and the pig-mixer are examined; charcoal pig may be obtained of suitable quality, but coke pig must be passed through a mixer. Furnaces for melting cast iron are discussed; O. is an advocate of reverberatories or of electric furnaces for use in the foundry. (*J.I.S.I.*)

Gaseous cementation of iron and steel. IV. Action of mixtures of carbon monoxide and ammonia on iron and steel and its bearing on process of cementation. A. BRAMLEY AND G. TURNER. *Iron Steel Inst., Carnegie Schol. Mem.*, **17,** 23–66 (1928).—Cementations of Armco iron at various temperatures with mixtures of carbon monoxide and ammonia showed that the carburizing action of the mixtures was much greater than that of carbon monoxide alone; this stimulating action was attributed partly to the formation of cyanides, and partly to the influence of the hydrogen formed by the decomposition of the ammonia on the carbon-monoxide/carbon-dioxide equilibrium. The distribution of nitrogen in the cemented zones resembled closely that due to the use of mixtures of carbon monoxide and methyl cyanide, but the mode of distribution of the carbon was more suggestive of the effect produced by pyridine. The carburizing power of mixtures of carbon monoxide and hydrogen was greater than that of carbon monoxide alone, but less than that of carbon monoxide and ammonia. The substitution of nitrogen for carbon monoxide in admixture with ammonia caused the production of less nitride. The depth of penetration of carbon at various temperatures was about the same as when carbon monoxide mixed with pyridine and methyl cyanide was used under corresponding conditions. The changes in dimensions of the bars produced by cementation depended on whether the operation was carried out above or below 900°C. They were of the same order of magnitude as those reported in Parts I to III (**15,** 17 (1926); **16,** 35 (1927)). The micrographs showed that the presence of nitrogen entirely altered the microstructure of the iron-carbon alloys, particularly when cementation occurred below 800°C; in cementations above that temperature marked segregation of carbide took place. The needles characteristic of steel treated with nitrogenous cements occurred in definite zones, the limitations of which appeared to be controlled by the nitrogen concentration. (*J.I.S.I.*)

Inclusions in iron. C. R. WOHRMAN. *Trans. Amer. Soc. Steel Treating*, **14,** 81–126, 255–99, 385–414, 539–79 (1928).—W. presents the results of a photomicrographic study of inclusions in iron. Chapter I is introductory. The methods used for making artificial known inclusions desired for the studies are described; the preparation of specimens, in particular the methods of polishing for inclusions, are considered and the

technique of microscopic examination is dealt with. The oxide, sulphide, and oxide-sulphide inclusions are described in Chapters II, III, and IV, respectively. Their appearance and typical occurrence is noted as well as their etching characteristics in the more common reagents used in metallographic work. Particular attention is paid to the constitution of the inclusions and to the much-disputed questions relating to their origin and behavior. In Chapter V the evidence is summarized, discussed, and correlated with accepted theories and hypotheses about the nature of inclusions. The sources of inclusion-forming materials, the status of inclusions in the molten metal and their formation are discussed, and the conditions governing their size, shape, and distribution are outlined. The behavior of inclusions, their occurrence at grain boundaries, and preferential association with the pro-eutectoid elements are also discussed, and the problem of identification of inclusions is touched upon. The phenomenon of red-shortness receives special attention and a new explanation for it is offered. A bibliography of literature on the subject is appended to the paper. (*J.I.S.I.*)

Gas-fired frit furnaces bring fuel economy. J. B. NEALEY. *Ceram. Ind.*, **12** [5], 559 (1929).—The Detroit Michigan Stove Co. uses two frit furnaces: (1) for melting the frit for the ground coat and (2) for the frit used in making up the white coat. These furnaces were formerly coal-fired which afforded important comparative data as to the use of these two fuels in the manufacture of the same product. These show that a better quality of frit, a better finish to the work, and a better surface are produced with the use of gas. The chemical reaction and smelting time has been cut 25%, with the use of gas, while the resulting frit is more easily ground, about one-third of the time being saved in this latter process. A week's test run shows that the average gas consumption per batch is 6060 cu. ft. with the gas used for heating up, prior to charging, added in. This reduces to 7.94 cu. ft. of gas per pound of frit charged and with gas at 56¢ per 1000 cu. ft., the fuel cost amounts to only $0.00445 per pound of frit produced.

F.P.H.

PATENTS

Apparatus for enameling. JOHN M. SULLIVAN. U. S. 1,710,953, April 30, 1929. (1) An enameling apparatus comprising a housing, a rotary spraying device including a nozzle within the housing adapted to emit liquid enameling composition, traveling means passing through the housing, the traveling means being adapted to carry the article being enameled through the housing whereby the article is sprayed with enameling composition, means whereby the nozzle may be adjusted toward and away from the traveling means to fixed spraying positions, and means whereby the speed of travel of the traveling means may be regulated. (2) An apparatus for enameling comprising a housing, a spraying device, the spraying device comprising a conductor through which liquid enameling composition is passed, a tube surrounding the conductor and extending longitudinally thereof, the tube being of greater diameter than the conductor so that an annular space is provided within the tube between the inside face of the tube and the outside face of the conductor through which space compressed air is passed, a nozzle carrier fixed to the tube and adjustable longitudinally thereof, the nozzle carrier including laterally extended arms, a pair of oppositely disposed nozzles supported by the laterally extended arms, the nozzles being adjustable longitudinally of the laterally extended arms, flexible means connecting the conductor and the annular space with the nozzles, and means whereby the tube may be rotated.

Enamels. DEUTSCHE GASGLÜHLICHT-AUER-GES. Brit. 306,019, April 10, 1929. An opaquing medium, suitable for use in enameling metal, is made by fusing zirconium silicate with about the equimolecular quantity of oxide of calcium, barium, strontium, magnesium, or zinc, in the presence of a small quantity of a flux such as enamel. For example, 189 parts of zirconium silicate are mixed with 100 parts of lime and about 20 parts of flux, and the mixture is heated to about 800°C.

Enamels. E. C. R. MARKS. Brit. 307,259, May 1, 1929. Lepidolite and similar materials, and synthetic compounds of similar chemical composition, are used as an enamel, particularly for enameling iron articles. The substance is pulverized and, without any other binder, is floated with water on the object to be enameled and is fired at a temperature of 1000°C. The coating of enamel so formed is opaque and glossy, and does not require a coating of base enamel.

Enameling castings. W. ECKHOFF AND L. DEUSSENER. Brit. 307,674, May 8, 1929. Relates to a method of preparing castings for enameling, particularly with lead-free enamel, in order to obtain, a finished surface free from the blemishes caused by air and moisture enclosed in pores in the castings. The surface of the casting, after it has been cleaned and before the enamel is applied, is treated with a highly inflammable material such as petrol. The material forms a protective layer and prevents the enamel from penetrating the pores of the casting until all the water present has evaporated. The protective layer burns off when the enamel is dried and fired. When dry powdered enamel is used, the powder may be mixed with the inflammable material instead of with water.

Glass

Physical properties of glasses and their relation to the composition. The mechanical properties of glasses. G. GEHLHOFF AND M. THOMAS. *Glass Ind.*, **10** [4], 83–88; [5], 114–19 (1929); communication from the Technical Glass Laboratory of the Osram Co., Weisswasser, Germany; *Z. Tech. Physik*, **7**, 105–26. Translated for the *Glass Ind.*—Data on the mechanical properties of glasses are valuable in many ways both to the glassmaker and to the user. For glass as a building material (glass roofs, window panes, etc.) one is interested essentially in the transverse and impact strength. For grinding apparatus, crystal and optical glasses, the hardness is of great importance. Most are interested in tensile strength and the modulus of elasticity because these properties are important in the thermal resistance. The investigations conducted were density, tensile, transverse, compressive, impact, scratch hardness, and modulus of elasticity, and the effect of different glass formers on these properties. When strain was removed the test rods increased in density about two units in the second decimal place. Density varies when SiO_2 is partially replaced by Na_2O, K_2O, MgO, CaO, ZnO, BaO, PbO, B_2O_3, Al_2O_3, and Fe_2O_3 within percentage range only with ZnO, BaO, Al_2O_3, Fe_2O_3. Therefore it is evident that the calculation of the density from the composition is permissible only within narrow limits.

TABLE I

	0–5%	5–10%	10–15%	15–20%	20–25%	25–30%	30–40%	40–50%	50–60%
Na_2O			0.017	0.010	0.008	0.006			
K_2O				0.005	0.003				
MgO	0.012	0.012	0.006						
CaO	0.018	0.016	0.014	0.012	0.009	0.007			
ZnO	0.021	0.021	0.021	0.021	0.021	0.021			
BaO	0.024	0.024	0.024	0.024	0.024	0.024	0.024		
PbO	0.024	0.024	0.026	0.027	0.029	0.032	0.034	0.037	
B_2O_3	0.018	0.010	0.003		−0.004	−0.005	−0.005	−0.006	−0.006
Al_2O_3	0.006	0.006	0.006						
Fe_2O_3	0.013	0.013	0.013	0.013	0.013	0.013			

By means of the data given in Table I, it is possible to calculate approximately the density of a given glass if the density of a similar glass is known. Tensile strength coefficients for the oxides were calculated on assumed linear relation between composition and tensile strength. The values for CaO and MgO, according to Schott are particularly unreliable. The constituents in the order of their effect on tensile strength are ZnO,

SiO_2, B_2O_3, BaO, Al_2O_3, PbO, Na_2O, K_2O. Strains and fire gloss have slight influence on tensile strength.

	Tensile strength
Strained rod	3.97 kg./sq. mm.
Annealed rod	4.16 " " "
Etched strained rod	4.16 " " "

Alkalis raise the tensile strength and potash acts more strongly than soda. CaO, BaO, and PbO increase tensile strength; CaO is the strongest, then comes BaO, and PbO. With CaO and BaO there is an optimum in the vicinity of 25%. On tensile strength BaO, CaO, and PbO are in the same order of influence as on electric conductivity and annealing temperature. MgO and ZnO have only a slight effect on the tensile strength. MgO glasses most generally crack. B_2O_3 gives a very noteworthy curve with optimum of tensile strength at about 15%, optimum tensile strength exactly corresponding with the most favorable content for solubility and many other properties. Al_2O_3 and Fe_2O_3 increase the tensile strength to a slight extent. Table II gives the amount by which the tensile strength changes when 1% SiO_2 is replaced by 1% of the oxide in question within a certain percentage range.

TABLE II

	0–5%	5–10%	10–15%	15–20%	20–25%	25–30%	30–35%
Na_2O			0.01	0.02	0.04	0.06	
K_2O				0.05	0.07		
MgO		Effect very slight					
CaO	0.28	0.2	0.12	0.05			
ZnO		Effect very slight					
BaO	0.17	0.14	0.12	0.11	0.04	−0.08	−0.14
PbO	0.09	0.09	0.08	0.06	0.05	0.04	
B_2O_3	0.19	0.13	0.05	−0.06	−0.14		
Al_2O_3	0.16	0.05	0.03				
Fe_2O_3		Effect very slight					

The series given by Winkleman and Schott (ZnO, SiO_2, B_2O_3, BaO, Al_2O_3, PbO, Na_2O, K_2O) is entirely different and does not express the characteristic action of the boric acid glasses. Alkalis increase the transverse strength considerably, soda is a little stronger than potash. CaO, BaO, and PbO increase the transverse strength of the glasses strongly in order given but with a very high content of these oxides there is a decrease in the transverse strength. Similarly ZnO increases transverse strength a little at first and then it decreases. MgO has only a slight influence on transverse strength. B_2O_3 increases transverse strength a little attaining its maximum at about 15%. Table III shows the amount by which the transverse strength changes on replacing 1% SiO by 1% of another glass-former.

TABLE III

	0–5%	5–10%	10–15%	15–20%	20–25%	25–30%	30–35%
Na_2O			0.018	0.36	0.06	0.10	
K_2O				0.028	0.044	0.076	0.104
MgO	0.024	0.014	0.006				
CaO	0.08	0.06	0.024	−0.05(?)	−0.026		
ZnO	0.04	0.02		−0.016			
BaO	0.06	0.046	0.024	0	−0.004	−0.018	−0.038
PbO	0.046	0.036	0.026	0.006	−0.005	−0.16	
B_2O_3	0.025	0.02	0.014		−0.020		
Al_2O_3	−0.014	−0.014	−0.014				
Fe_2O_3	0.011	0.011	0.011				

The alkalis have by far the greatest influence on compressive strength. Both reduce the compressive strength, potash more than soda. Mixed alkali glasses show compressive strengths that are between those of glasses with only one alkali. MgO and ZnO

have only a slight influence on the compressive strength. CaO, BaO, and PbO, on the other hand, reduce the compressive strength strongly and about to the same extent. The compressive strength is slightly reduced by B_2O_3. Al_2O_3 slightly increases while Fe_2O_3 reduces the compressive strength. In Table IV is given the amount by which the compressive strength changes when 1% SiO_2 is replaced by 1% of another glass-forming oxide within a certain percentage range.

TABLE IV

	0–5%	5–10%	10–15%	15–20%	20–25%	25–30%
Na_2O			−1.6	−2.2	−2.6	
K_2O				−2.4		
MgO		Very slight				
CaO	−2.0	−0.8	−0.2			
ZnO		Very slight				
BaO	−1.4	−0.8	−0.5	−0.3	−0.3	
PbO	−2.0	−1.1	−0.4	−0.3	−0.2	
B_2O_3			−0.5	−0.7	−0.8	
Al_2O_3	0.25	0.25	0.25			
Fe_2O_3	−0.5	−0.6	−0.8	−1.4		

E.J.V.

Factors affecting the composition of common glassware. J. B. KRAK. *Glass Ind.*, **10** [5], 107–109 (1929).—Practical experience has shown that glass becomes stronger, easier to melt, has better working qualities, and is in general more suitable for machine production with increase in the number of elements it contains. The use of feldspar and of dolomitic limestone to introduce alumina and magnesia has become general. The advantages of alumina in glass can be summarized as follows: alumina (up to about $2^1/_2$%) lowers the coefficient of expansion, thereby making glass more resistant to thermal shock, increases the mechanical strength, crushing and tensile strengths, increases resistance to weathering and attack by liquids, increases brilliancy and luster, increases working range of molten glass, making it more suitable for machine production, increases fusibility where it replaces lime or silica, and makes the glasses less corrosive in their action on the tank blocks or pots, decreases scum and devitrification, and where it replaces silica it produces a more solid, elastic, and ductile glass. Another material recently made available to makers of common glassware, due to large quantity production, is borax. The advantages of boric oxide in glass can be summarized as follows: borax, even in small amounts such as 50 to 1000 lbs. of sand, makes possible a heavier pull on the tank without danger of seeds; boric oxide decreases thermal expansion, gives glass greater resistance to mechanical shock, increases resistance to the solvent action of contained liquids, and gives the ware a greater resistance to pressure breaking. Based on the above considerations a batch formula has been developed which has given excellent results. The outstanding advantages of glass of this nature are its resistance against the action of solvents and weathering, the ease with which the glass is melted and fined, the good working qualities in automatic machinery and the large output of high grade glass which is obtainable.

Batch formula		Glass composition	
Sand	1000	Silica	73.85%
Soda ash	360	Sodium oxide	15.46
Salt cake	5	Potassium oxide	0.62
Lime (burnt)	110	Calcium oxide	7.59
Feldspar	100	Alumina	1.24
Borax	50	Boric oxide	1.24
			100.00

E.J.V.

New glass edging machine. JOSEPH CAPPELMAN. *Glass Ind.*, **10** [4], 102 (1929); for abstract see *Ceram. Abs.*, **8** [2], 101 (1929). E.J.V.

Glass melting furnace practice. W. A. MORTON. *Amer. Glass Rev.*, **48** [31], 15–18 (1929); *Nat. Glass Budget*, **45** [1], 3 (1929).—As recently as 1910, glass tank furnaces were designed to produce a ton of planed metal on 14 to 18 sq. ft. of hearth; hand working was in vogue, large refining chambers a necessity, 2 lbs. of coal per lb. of glass required, regeneration meager, fuel economy poor, and air preheat and flame temperatures low. Glass was difficult to plane because of poor ebullitive activity due to high viscosity; color was rarely the same from day to day, and pot furnaces were required for quality metal. Today many tanks produce glass which can hardly be distinguished from pot glass. For years tank-furnace designs called for 14 to 18 sq. ft. of hearth per ton of glass per 24 hrs., and regenerators were rarely supplied with an excess of 6 ft. depth of checkers using natural gas. Furnaces fired with coal gas were sluggish and rarely performed as those fired with natural gas. In 1920, the "High Duty Port" or fixed brick burner for raw gas-fired glass-melting tanks lowered ratings to 8 to 10 sq. ft. per ton of metal, fuel velocities increased, and gas and air mixed more remote from the furnace. A well-balanced regenerative glass-melting furnace will produce a ton of glass on a melting hearth area of 6 sq. ft. not using excessive temperatures (2600 to 2650°F). The fuel supplied is about 4300 B.t.u. per pound of glass. The average gas velocity through the air chambers is 2 ft. per sec.; gas checkers, 3 ft. per sec.; air uptakes, 25 ft. per sec.; ports, 35 ft. per sec. Preferred average air temperature is 1950°F. Preferred average gas temperature is 1600°F. Flame direction is a function of port velocity; flame area port design; flame propagation of internal port design, a feature neglected and rarely found. Generally, producer gas-fired furnaces will have excess fuel forward on the hearth, resulting in low-flame temperature, and excess air is delivered to the ports adjacent the charging end of the furnaces lowering the temperature. Refining temperatures vary with size of refiner, production rate and temperature difference between the glass in refiner and that delivered from the melting end. Rate of glass flow usually is greatest through the center of the tank and is submerged on entrance to the refining end. Glass will rise to the surface by convection and refining progresses if adequate refining was not obtained within the melting chamber. Temperature conditions will cause a "reboil" due to the absence of temperature difference between the melting and refining end which limits convectional action when refining has not been completed in the melting chamber. Recuperative glass-melting furnace will supersede the regenerative furnace. Recuperative furnaces melt more glass with less fuel than the latest types of regenerative furnaces, regardless of capacity comparison. Glass is being produced in two small machine tanks with as low as 3700 B.t.u. per lb. of glass or about 20% less than the best regenerative types now in operation. Double the amount of glass will be produced with the same amount of fuel. The shallow hearth has contributed a lustrous quality of metal unequaled in regenerative furnaces. Color is more constant and easier to control because 50 to 60% of the total metal may be removed daily from the furnace, as compared to about 25% in generative tanks of 42 in. depth. This reduced quantity of metal is less susceptible to variation because it is processed quicker and responds more readily to heat application than a larger body. Bridgeless tank, generally adopted, has been used in Europe many years. E.P.R.

Better mixing of glass batches. H. E. DE WEERDT. *Ceram. Ind.*, **12** [5], 534 (1929).—Much depends upon the mixing speed for uniform distribution of the constituents. Different grain sizes with different specific gravities are to be kept moving into the whole batch without collecting and without separating. Dry particles will easily cake with moist ones, resulting in lumps or unmixed materials. The mixing time depends largely on the speed, the ways followed by distribution, the number of revolutions of each grain, and the number of points of contact between the latter. This new counter-current batch mixer consists of a revolving mixing plate and mixing

shovels in opposite directions, full batch on the plate only 5 inches thick, mixing tools with roller to break nodules from the mixing shovel, thus producing a counter-current flow in the batch, flattening and rubbing nodules, but not crushing the particles. When planning the installation of this mixer the following points should be considered: (1) a sketch showing feeding and conveying device in order to adapt mixer; (2) production in liters wanted per hour or day; (3) size of largest grain in constituents; (4) if cullet is used, grain size; (5) state of materials, dry or moistened; (6) bottom hopper for ready batch; (7) choice of belt drive or direct motor drive. F.P.H.

Molds cause defects in blown glassware. ROY E. SWAIN. *Ceram. Ind.*, **12** [5], 535–57 (1929).—Articles made in paste molds have certain defects, mold marks, water marks, chills, and crizzles. The cause and correction of these are explained. For previous article on this subject see *Ceram. Abs.*, **8** [2], 101 (1929). F.P.H.

Design of hand-operated blow molds. ROY E. SWAIN. *Glass Ind.*, **10** [4], 79–82 (1929).—Blow molds are usually divided into two classes, paste molds and iron molds. Between the paste molds and iron molds are some molds in the nature of a compromise or in combination. The various types are described. Among the many details of mold construction that do not bear particularly on any one style of mold but help to make the mold workable and more satisfactory are hinges, locking devices, air vents, and dirt grooves and vents. These details are discussed. E.J.V.

Laminated safety glass. IV. JOSEPH ROSSMAN. *Glass Ind.*, **10** [4], 88–90 (1929).—Sixteen patents bearing on the manufacture of laminated safety glass are discussed; *i.e.*, ophthalmic lenses, alarm glass, eye-protecting goggles, compensating press, wire-glass, apparatus for making reinforced glass, shock-resisting glass, laminating glass under incremental differential pressures, uniting vitreous pieces, and laminated glass. For previous articles see *Ceram. Abs.*, **8** [3], 181; [5], 325–27(1929). E.J.V.

Expansion factor of aluminum oxides. ANON. *Fuels and Fur.*, **6** [11], 1580 (1928).—The abstract of a paper presented by I. Kitaigorodsky and S. Rodin at the meeting of the Society of Glass Technology, Bournemouth, England. In calculations of the theoretical coefficient of glass, it is stated that the value of the factor for alumina is 0.52. A.E.R.W.

Ultra-violet transmission glass. A. E. INGALLS. *Sci. Amer.*, **140** [4], 338–43 (1929).—Observations on the physics and physiology of special window glass for transmitting ultra-violet rays are given. T.W.G.

Reaction of glasses to diluted alkali solutions of normal concentration at high temperatures. F. FRIEDRICHS. *Sprechsaal*, **61** [36], 713–15; [37], 730–31; [38], 751–54 (1928).—The loss of weight, and the loss or gain of alkali, between 100 and 300°C have been determined for five typical glasses and the results presented in tables and curves. Glasses rich in alumina show formation apparently of leucite. Foerster's observation that alumina favors the resistance of glass to alkali hydroxide is substantiated. Alkali carbonates will attack such glass more forcefully than will hydroxides. A high boracic acid glass absorbs 48% water. T.W.G.

Silvering curved reflectors. L. LIPKIN. *Sprechsaal*, **61** [38], 754 (1928).—L. points out the disadvantages of pouring and spraying and recommends for smaller plants the silver leaf method with gelatin (instead of shellac). T.W.G.

Thermic movements in glass melts. E. BERGER. *Sprechsaal*, **61** [42], 827–31 (1928).—Movements appear only if the glass contains communicating columns of different temperatures where the glass within the hottest column flows opposite to gravity. Fully illustrated. T.W.G.

Annealing glass. E. ZSCHIMMER. *Sprechsaal*, **61** [44], 869–72 (1928).—Many glasshouses merely temper the ware and then leave it to cool. In many cases a complete elimination of all strains is not needed and a tempering process following natural

cooling will suffice. Much glassware would do well to be hardened after tempering. Good cooling means uniformly distributed surface tension. Tempering has to equalize first differences in tension. The proper tempering temperature of the oven must be determined for each case. Z. gives various methods for such theoretical determination, discusses annealing ovens, and points to Coad-Pryor's sound principle of annealing within a well-insulated tunnel without heat and free from draft. T.W.G.

Heat conductivity of glasses. A. RUSS. *Sprechsaal*, **61** [45], 887–91; [46], 907–12 (1928).—Heat conductivity and its coefficient in a series of glasses is investigated between 0 and 100°C, obtaining the following gradation: SiO_2, B_2O_3, MgO, Al_2O_3, Fe_2O_3, ZnO, CaO, Na_2O, PbO, BaO, K_2O. An attempt is made to calculate the conductivity from the components of a glass, the discrepancy between the measured and calculated value being only $\pm 1.66\%$. Heat conductivity is additive, or nearly so, in analogy with expansion and specific heat. Results of former investigators could be checked satisfactorily. The apparatus and method for measuring used by Eucken has been improved in a number of ways. T.W.G.

Reaction of glass to caustic soda at high temperature. F. FRIEDRICHS. *Sprechsaal*, **61** [49], 967–69; [50], 980–86 (1928).—Loss of weight and loss or gain of alkali were determined on 14 different glasses between 100 and 300°C. With strongly acidic glasses the loss of weight after a period of time becomes constant for a certain concentration of solution. T.W.G.

Testing glasses for chemical resistance. LUDWIG SPRINGER. *Sprechsaal*, **62** [11], 187–90; [12], 206–209 (1929).—Testing was done on containers and window glass and results are given. Laboratory testing in conjunction with factory testing is recommended. T.W.G.

Composition and hydrolytic resistance of commercial pressed glass. C. A. BECKER AND C. KRAFT. *Sprechsaal*, **62** [15], 261–62 (1929).—The range for commercial pressed glass was found to be 74.5 to 76.0% SiO_2, 4.5 to 8.5% CaO, 15.0 to 20.0% alkalis. T.W.G.

Heat exchange in glass melting furnaces. ANON. *Fuels and Fur.*, **6** [7], 918 (1928).—The abstract of a paper presented by D. Aufhauser at a joint meeting of the Society of Glass Technology and the Deutsche Glastechnische Gesellschaft at Aachen. Rates of heat exchange in glass furnaces are discussed. A.E.R.W.

Glass buildings. ANON. *Ceram. Age*, **12** [4], 158 (1928).—Plans are being drawn for a number of structures which are to be built almost entirely of plate glass. The seven-story Hallidie Bldg. in San Francisco is the first "all plate-glass front" building in the U.S. Important buildings of glass have been constructed in Russia and Germany. Glass is completely impervious to air. The thermos principle may be used in wall insulation in the future. A.E.R.W.

Uviol glass for solariums. ANON. *Nat. Glass Budget*, **44** [51], 17 (1929).—The New York Athletic Club has equipped its solarium with glass through which the ultraviolet rays of the sun may pass. E.P.R.

Maltese X-ray lead glass. ANON. *Nat. Glass Budget*, **44** [50], 7 (1929).—Maltese X-ray lead glass is said to offer increased protection, effective observation, and immensely improved vision. E.P.R.

Glass containers. ANON. *Nat. Glass Budget*, **44** [49], 11 (1929).—Glass containers are retaining their supremacy over paper containers for food-carrying purposes. E.P.R.

Grading and sizing of sand. LEROY W. ALLISON. *Cement, Mill & Quarry*, **34** [5], 18–22 (1929).—Typical plant installations are described. E.P.R.

New tongs for leaded glass. ANON. *Amer. Glass Rev.*, **48** [29], 16 (1929).—A new bench tong for use in the manufacture of leaded glass, art glass, and similar prod-

ucts is made of hardened tool steel with sharp milled teeth in the jaws which hold firmly the leaded mold while being worked. E.P.R.

Dixon's vanad iron. ANON. *Amer. Glass Rev.*, **48** [20], 19 (1929).—Gratifying reports are received on the big savings effected by Dixon's Improved Vanad Iron for molds. It results in a minimum of scaling, shock, and erosion, and will produce a much better finished ware. E.P.R.

New "Armor-Plate" glass. ANON. *Amer. Glass Rev.*, **48** [30], 24 (1929).—The Pittsburgh Plate Glass Co. announces the selection of the name "Armor-Plate" for the bullet-proof glass now being manufactured by the company. E.P.R.

New annealing leer installed. ANON. *Crockery & Glass Jour.*, **107** [5], 69 (1929).—A new type muffle leer to be installed for the Dunbar Flint Glass Corp., Dunbar, W. Va., by the Simplex Engineering Co., will increase production capacity. E.P.R.

Owens Bottle Co. combines with Illinois Glass Co. ANON. *Amer. Glass Rev.*, **48** [27], 15–16 (1929); *Nat. Glass Budget*, **44** [50], 3 (1929); **44** [52], 12 (1929); *Crockery & Glass Jour.*, **107** [4], 60 (1929); *Glass Ind.*, **10** [4], 92a-92c; [5], 125–26 (1929); for abstract see *Ceram. Abs.*, **8** [6], 403 (1929).

Add new unit to glass sand plant. ANON. *Glass Ind.*, **10** [5], 102 (1929).—Plans are being made to increase the size of the plant of the Eastern Silica and Chemical Co., of Winchester, Va., which is producing 400 T. of glass sand every 24 hrs. For previous article on this subject see *Ceram. Abs.*, **8** [2], 104 (1929). E.J.V.

Window-glass plant for Oklahoma. ANON. *Glass Ind.*, **10** [5], 127 (1929).—The city of Henryetta has been selected by the Pittsburgh Plate Glass Co. as the site for their new Southwestern window-glass plant. Production capacity will be about 900,000 boxes of window glass per year. The plant will be equipped with the flat glass-drawing process developed at the plants at Mount Vernon, Ohio, and Clarksburg, W. Va. E.J.V.

Modernization of glass plant. ANON. *Ceram. Ind.*, **12** [5], 532–34 (1929).—A discussion of the modernization of the plant of the Southern Glass Co., at Los Angeles, Calif., is given. F.P.H.

Glass industry at Birmingham, England. ANON. *Ceram. Age*, **12** [5], 181 (1928).—Abstracted from *Commerce Reports*, U. S. Bur. of Foreign and Domestic Commerce. A.E.R.W.

Chinese glass industry. ANON. *Pottery Gaz.*, **54** [622], 647 (1929).—The Japanese have been trying for many years to obtain an economic preponderance in China and owing to the large market for glass, they have established 10 glass factories. Most of the raw materials are found in China. The chief product is lamp chimneys, but in some of the more modern plants window glass is also being produced now, though European glass furnishes strong competition. The production of mirror and other glass is under consideration. E.J.V.

Geographical distribution of the glass industry. L. M. ANGUS-BUTTERWORTH. *Pottery Gaz.*, **54** [623], 793–95 (1929).—A survey of the present position in each of the chief glass-producing countries, and an indication of the probable lines of development in the immediate future are given. The countries discussed in this survey are the U.S., Germany, Czechoslovakia, France, Belgium, the Netherlands, Japan, and the Indian markets. E.J.V.

Flat glass in Belgium in 1928. ANON. *Amer. Glass Rev.*, **48** [28], 15 (1929); *Nat. Glass Budget*, **44** [49], 10 (1929); **44** [50], 3 (1929).—Manufacture of Belgium glass for export dates back many generations. With abundant skilled labor, raw materials, cheap coal, and knowledge of export technique, the Belgian glass workers were in a dominant position. The Fourcault system of mechanically drawing glass has now al-

most entirely superseded the old blown system. Only six tanks now operate by the mouth blown method, these specializing on photographic glass or unusual grades.

E.P.R.

Chile enacts law subsidizing manufacture and exports of plate glass. ANON. *Amer. Glass Rev.*, **48** [20], 22 (1929). E.P.R.

Bohemian Fourcault machines in Czechoslovakia. ANON. *Nat. Glass Budget*, **44** [51], 23 (1929).—Ten window-glass manufacturing plants in Czechoslovakia are now using Fourcault machines. E.P.R.

PATENTS

Conveyer for annealing furnaces. WILLIAM ALFERINK. U. S. 1,710,332, April 23, 1929. (1) A sheet separating apparatus for furnaces, comprising a conveyer adapted to convey upper and lower sheets thereon in overlying relation, and means at the outlet end of the conveyer to separate and discharge the upper and lower sheets, respectively, to different places, the means comprising a pair of receiving devices movable to alternately register the same with the end of the conveyer. (2) The combination with a conveyer, of means at the inlet end thereof to feed sheets thereto in upper and lower lapped relation, comprising separate feed rolls at different heights and guides associated with the respective rolls.

Glass apparatus. LEONARD D. SOUBIER. U. S. 1,710,789, April 30, 1929. The combination of a furnace tank for molten glass, a plurality of channels communicating therewith, a return passageway between the channels, and a single actuating device working in the return passageway and operable to produce an outward flow of glass from the tank through all of the channels and back to the tank through the return passageway.

Glass-working tank. LEONARD D. SOUBIER. U. S. 1,710,790, April 30, 1929. The combination with a tank, means for supplying molten glass thereto, and means for rotating the tank, of means extending circumferentially of the tank over the glass therein for directing heated gases along the surface of the glass in different paths, and means for differentially controlling the movement of the gases in the paths.

Glass-serving apparatus. HOMER BROOKE. U. S. 1,712,327, May 7, 1929. Apparatus for serving glass including in combination with a glass furnace and a lateral bay therein having a discharge orifice in its bottom, a vertically reciprocatory plunger for closing the orifice, a tilting dumping trough arranged under the orifice onto which slugs of glass flowed through the orifice are delivered, means for severing a slug after each descent of the plunger to close the orifice, and means for moving the dumping trough to slug-discharging position after each operation of the knives, the trough being arranged close to the discharge orifice and moving at a rate of speed which causes the major portion of the slug to be laid down thereon as the slug is discharging, and means for laying down the hot tail end of the slug on the dumping trough before the slug is dumped, comprising a member arranged in the path of the slug to mechanically smooth down the hot tail end of the slug as the trough is moved.

Glass-pressing machine. MAX JAEGER. U. S. 1,712,499, May 14, 1929. (1) In a machine of the class described, the combination of a continuously rotating mold table, press molds carried by the table, a pressing member adapted to oscillate laterally of itself in a path above the path of the press molds and to engage charges in successive molds, and means controlling the time of such oscillations. (2) In a machine of the class described, a power cylinder, a piston within the cylinder, a supply of fluid under pressure, valve means to normally control the admission and discharge of pressure fluid to the cylinder, and a device for rendering the valve means ineffective and admitting pressure fluid to the cylinder to move the piston to a predetermined position. (3) In a machine of the class described, a pivoted frame, a valve carried by the frame, the valve

having at least two positions, a traveling cam for putting the valve in one position, and a stationary cam adapted to put the valve in another position as the frame swings with respect to the cam.

Mechanism for conveying and discharging lamp bulbs. HARRY DE FOREST MADDEN. U. S. 1,712,670, May 14, 1929. A machine for handling fragile articles comprising supporting means for the articles, a container to receive articles, a conveyer having one end disposed for the delivery of articles to the container, means for discharging articles from the supporting means to the conveyer and means for counterbalancing the conveyer in adjustable relation to the container to avoid detrimental contact between the free end of the conveyer and the fragile articles as the articles accumulate.

Transferring apparatus for continuously-rotating glass-forming machines. DAVID STENHOUSE. U. S. 1,712,907, May 14, 1929. An apparatus of the character described, including a continuously revolving table, a pair of grippers carried by the table, a vertically reciprocable rod, an operative connection between the grippers and the rod, and a stationary cam track adapted to be engaged by the rod during the rotation of the table.

Manufacture of translucent hollow glass articles (milk glass bulbs for electric incandescent lamps). MARCELLO PIRANI. U. S. 1,713,394, May 14, 1929. Method of making translucent hollow glass bodies, which comprises finely-pulverizing glass, sintering the glass, melting onto a gob of the sintered glass the end of a glass tube and blowing the article through such tube while quickly heating the gob to blowing temperature to maintain uniform distribution of the small air or gas pockets within the mass.

Drawing glass. A. BOUFFIOUX. Brit. 305,575, April 4, 1929. Relates to a drawing apparatus of the kind in which a sheet is drawn upward by pairs of opposed rollers, one roller of each pair being carried by counterbalanced arms. According to the invention, the counterbalanced arms are supported on knife edges which allow the rollers to yield when an undue thickening of the sheet passes between a pair of rollers. The suspension comprises a ring which is secured to either of the arms that carry a roller and is formed with an oval bore having a V-shaped notch on its upper surface. The notch rests on a knife edge formed on, or secured to, a stub shaft which is bolted to the frame of the machine. The arm is free to rock on the knife edge, and the shape of the bore permits free movement of the arm.

Polishing sheet glass. SOC. ANON. DES ATELIERS HEUZE, MALEVEZ, ET SIMON RÉUNIS. Brit. 306,023, April 10, 1929. The guide rails supporting the moving tables of machines for polishing glass and similar materials are provided at intervals with expansion joints arranged in staggered relation. The gaps between adjacent rail portions are bridged by resilient metal plates which yield when expansion of the rails occurs and which are secured to each other and to the rails to maintain the rail alignment. A tray is located beneath the connecting members and legs are provided on the rail webs to direct any oil which runs down from the rails into the tray. The rails are cross-connected by bars.

Grinding sheet glass. SOC. ANON. DES ATELIERS HEUZE, MALEVEZ, ET SIMON RÉUNIS. Brit. 306,025, April 10, 1929. In a driving device for the tool for grinding and polishing plate glass or similar material, the hub of the driving gear is slotted and is connected to the tool spindle by a cross-pin carrying ball-bearing rollers engaging in the slots so that the tool is free to move axially to maintain even pressure on the work and to compensate for wear. In a modification, the pin may be fixed in the hub and may carry ball-bearing rollers engaging in a slot in the tool-spindle.

Forming glass threads. S. G. S. DICKER. Brit. 306,332, April 17, 1929. A device for making glass threads comprises a pair of upright headers which support a number of glass rods, means for rotating the rods, burners for heating the ends of the rods, a wheel for drawing the threads, and means for moving one of the headers toward the

other in order to keep the burners in proper relation to the ends of the rods. The headers are carried by a support similar to a lathe bed, the 1st header being fixed to the support while the 2nd header is attached to a saddle which is moved along the bed by means of a leading screw. The 1st header supports a number of chucks arranged in two rows and connected to one another by gear wheels. The screw and the wheels are driven by a belt cone, and a gear box on the saddle enables the traversing speed of the header to be varied in relation to the speed of rotation of the chucks. The header is provided with a series of holes corresponding in position with the chucks and each hole is adapted to support one end of a glass rod which is gripped at the other end by a chuck. The header also carries a mixing chamber connected to supplies of gas and air and fitted with burners adjacent to each of the holes. In use, the glass rods are held and rotated by the chucks the free ends being melted by flames from the burners. Glass threads are drawn from the ends of the rods to the peripheral surface of a wheel or drum and the rotation of the drum draws the glass into continuous threads which are wound on its surface. The traversing speed of the saddle is so adjusted that the ends of the glass rods are always supported and maintained in proper relation to the burners. The surface of the drum is covered with burlap in order to increase the adhesion of the glass threads and also to set up air currents which tend to drag the threads around the drum. The sides of the drum may be covered with plates in order to reduce air resistance and air disturbance.

Glass manufacture. Compagnies Réunies des Glazes et Verres Speciaux du Nord de la France. Brit. 306,441, April 17, 1929. A method of making plate and sheet glass in which molten glass flows through a slot in the wall of a tank furnace and is passed between rollers by which it is formed into a continuous ribbon or strip, and the strip is carried by conveying-rollers through a leer. According to the invention, the glass is melted and refined in a pot furnace of usual construction, and the refined glass is poured into a small tank or regulating furnace from which it flows through a slot to the rolling-apparatus.

Glass manufacture. Capstan Glass Co. Brit. 306,495, April 17, 1929. A device for transferring articles, particularly for taking off glassware from the machine by which it has been formed, comprises a pneumatic device for holding an article by suction and transferring it from a mold to a conveyer, the article being inverted preferably while it is being transferred. The device is shown applied to a machine for pressing tumblers which are to be used for packing foodstuffs. Each of the press molds comprises a body and a bottom which is fitted to a plunger that slides vertically through the mold table. If an article is not removed, or if a charge of glass is not pressed properly, it is necessary that the mold should be cleared before receiving a new charge. For this purpose, a pneumatic cylinder is arranged to move a pusher over the mold in the position after the take-off station. In this position, the plunger is lifted by a pneumatic cylinder, and the pusher removes any glass which may have remained in the mold.

Annealing and rolling glass. C. Heuze. Brit. 307,302, May 1, 1929. Relates to the intermittent method of producing plate or sheet glass in which a charge of molten glass is converted into a strip or ribbon by a double-roll machine, the rolling being conducted at a relatively high speed. The strip thus produced is fed into a leer through which it travels at a relatively low speed. According to the invention the strip, as it leaves the rolling-apparatus, is received on a transporting table with a surface formed of parallel rollers, and the speed of these rollers is varied between the speeds of rolling and annealing, the strip being maintained in constant movement on the table until it enters the leer. Means are provided for regulating the cooling of the strip during the time it is carried by the transporting table.

Glass manufacture. S. G. S. Dicker. Brit. 307,563, May 1, 1929. A process for making glass, particularly glass having a low coefficient of expansion, consists in uniting

the mixed bath to form a coherent body, and then melting the body so formed. In an example given, a batch for a glass containing 85% of silica is finely divided and thoroughly mixed, and a quantity of the batch is pressed to form small rods, a pressure of 1000 kg. per sq. cm. being used. The rods are then sintered by heating them to a temperature of 900°C, or higher, producing bodies which can be directly heated in a flame without the use of a pot to melt and form glass. Either the pressing or the sintering process may be dispensed with; for example the batch can be mixed, before pressing, with a binding agent. Alternatively, a coherent body can be obtained by sintering a quantity of batch in a boat-shaped mold.

Hollow glassware. JOBLING & CO., LTD. Brit. 307,793, May 8, 1929. Glass vessels, such as beakers, distillation flasks, and other chemical glassware, liners of coffee urns, etc., have the interior and in some cases also the exterior surfaces roughened, wholly or in part, by sandblasting, frosting, etching, or otherwise, to prevent the "bumping" of liquids boiling therein and to retard the corrosion of the glass due to the effect of steam or chemical action.

Glass manufacture. S. G. S. DICKER. Brit. 307,994, May 8, 1929. A method of sealing glass to fused quartz consists in using as a sealing medium a glass which is substantially free from alkaline metals. The glass used for the seal preferably contains at least 75% of silica, at least 6% of boric oxide, and a small percentage of one or more of the oxides of aluminium, calcium, or magnesium. A suitable glass consists of 85% of silica, 12.5% of borax trioxide, and 2.5% of aluminium trioxide. A quantity of molten glass, having the composition given above, is applied to the rim of the quartz tube. A glass tube is welded to the molten glass, and the two tubes are drawn apart so as to form the plastic glass into a tube.

Heavy Clay Products

Clay sewerpipe manufacture. VI. Heat-balance determinations. R. E. ARNOLD AND G. H. DUNCOMBE, JR. *Jour. Amer. Ceram. Soc.*, **12** [6], 410–22 (1929).—Heat-balance determinations were conducted on a number of sewerpipe kilns and the kiln efficiencies were found to vary from 14.97 to 29.03%. The method of calculating the heat balance is described in detail. Kiln efficiencies for individual periods range higher for the second period in most cases with some of the kilns reaching to about 40% efficiency. In general as the kiln reaches higher temperatures the kiln efficiency decreases due to increasing stack and kiln structure losses. In all, 34 kiln tests were conducted in 6 plants in various sections of the country, in 26 of which heat-balance calculations were made, the remainder being auxiliary tests giving only general operating data such as tonnage of ware, fuel consumption, temperature schedule, and ware analysis.

Clay sewerpipe manufacture. VII. Low-temperature oxidation. R. E. ARNOLD AND G. H. DUNCOMBE, JR. *Jour Amer. Ceram. Soc.*, **12** [6], 423–28 (1929).—This is a second paper of a series dealing with an investigation of kiln design and operation. Data of plant and laboratory experiments on rate of oxidation of carbon found in sewerpipe clays are presented. The effect of some metallic oxides as catalysts in the low-temperature combustion of coal is investigated. The difference in rate and completeness of the combustion or volatilization of the various forms of carbon shown in the laboratory studies suggests one explanation of why the clays of the plant experiments oxidize with difficulty at higher temperature, *viz.*, that the material which forms the black core is of the type of carbon compound which burns readily at low temperatures, and that at higher temperatures it is "cracked" or changes into one of the forms of carbon which burns slowly.

Sewerpipe manufacture. VIII. Measurement of draft distribution. C. E. PARMELEE. *Jour. Amer. Ceram. Soc.*, **12** [6], 429–33 (1929).—A method used in measur-

ing the draft distribution in sewerpipe kilns is described and the significance of draft measurement in kiln studies is discussed. In the progress of the kiln studies several types of kiln bottoms were investigated. These ranged from one extreme to the other in the type and arrangement of flues and openings. The kilns studied had ring, spoke, spider, or "T" flue systems, together with solid or open-feature walls, and in some cases a double-feature wall system. Draft-distribution studies of these types of construction brought out widely varying conditions. The possibilities offered in correcting faulty conditions by the use of this method of measuring the distribution are discussed.

Brickmaking in Colombia, S. A. T. W. GARVE. *Bull. Amer. Ceram. Soc.*, **8** [5], 110–14 (1929).—A description of the manufacture of brick in Colombia, as observed around Baranquilla. All the brick are made by hand, two at a time, on the ground. The brick are dried in the sun for two days and then are fired in a wood-fired kiln for three days, with the result that they are underfired and not hard enough. The brick sell for about $22.00 per M. E.J.V.

Some new power-saving equipment. M. W. BLAIR. *Bull. Amer. Ceram. Soc.*, **8** [5], 114–18 (1929).—Several new types of power-saving and cost-reducing equipment have been introduced to the heavy clay products industry during the past year. Among the most important of these are a new grinding machine, a straight line, combined pug and auger machine, and a fan for use in waste-heat driers. Detailed descriptions of these machines are given. E.J.V.

Equipment in a modern clay plant. ANON. *Brick Clay Rec.*, **74** [9], 596–99 (1929).—Two flow sheets are published, the first picturing the mechanical handling equipment and methods employed between operations, and the second depicting the flow of the raw material through the different processes, listing at each processing point the machinery and equipment used in that operation. E.J.V.

Strength of sand-lime brick. ANON. Bur. Stand., *Tech. News Bull.*, No. 143, p. 25 (1929).—Twenty-five manufacturers of sand-lime brick have each furnished 50 bricks representing their regular production for use in an investigation at the Bureau of the properties of sand-lime brick. The absorption by total immersion in cold water has been obtained at 5-min., 5-hr., and 24-hr. periods, and in addition on boiling 5 hrs. Ten of each group of 50 bricks were then selected, using care to obtain a range in absorption, and reserved for freezing tests, to determine the weathering properties of the bricks. The other 40 bricks were broken transversely and the halves were then tested for compressive strength on edge. The results show the absorption to range from 13.7 to 21.6%, the modulus of rupture from 330 to 730 lbs./sq. in., the compressive strength, flat, 2150 to 4470 lbs./sq. in. and the compressive strength on edge from 1500 to 3850 lbs./sq. in. R.A.H.

Core cracking and lamination. ANON. *Brit. Clayworker*, **38** [444], 12–13 (1929).—Lamination, core cracks, and the "S" crack in the center of the clay column occur during brickmaking one time or another or all at once in most clays of highly plastic nature. Some suggestions are given which were taken from Bur. Stand., *Jour. Research*, **1** [6], 1023 (1928); *Ceram. Abs.*, **8** [2], 113 (1929), which should assist in eliminating these defects. R.A.H.

New textures for face brick. ANON. O. S. U. Eng. Expt. Sta., *News*, **1** [1], 9–10 (1929).—Tests made at Roseville indicate that face brick manufacturers are overlooking an attractive field of new colors that can be secured by salt-glazing shale brick. The siliceous part of the Putnam Hill (No. 4) shale and another stratum occurring immediately above Tionesta fire clay (3B) were used in the investigation. Briquets were fired in a gas-fired test kiln, until draw trials revealed a glassy fracture. Six saltings were then applied. The process of firing was completed with these two flashings. The rapid cooling which followed is believed to have contributed to the results. The briquets

bore flashings of orange, green, and salmon with some normal red coloring where close setting prevented the action of the salt. The effect of the salt was intensification of color, and the best results were obtained when enough was used to give only a very slight gloss to the surface. Another shale gave a good semigloss black color. Another development is a shell-like texture obtained by rolling coal into the clay column. Variation in coarseness of the coal particles will give any degree of roughness desired on the surface. Coals having an ash high in iron will leave delicate color markings on the pitted surface. A hard coal that fractures with jagged corners is desirable. If the deposit is to be removed after the ware is drawn from the kiln the ash should have a fusion temperature higher than that to which the brick are to be fired. Coal particles that are not coarser than 8-mesh or finer than 14-mesh produce the best-looking surface. The effect is most pleasing on buff-firing clays. Another interesting texture is obtained by rolling crushed cinders into the surface of the column. Shades of red, blue, brown, and black are obtained in the fused cinders which contrast well with a buff or cream body. This texture shows promise of duplicating a manganese speckled brick or an iron-spot face. For best results the brick must be fired to a temperature of about the fusion point of the cinders. F.P.H.

Firing brick with powdered coal. ANON. *Refrac. Jour.*, **4** [43], 228 (1929); *Building Sci. Abs.*, Dec. 1928; for abstract see *Ceram. Abs.*, **8** [1], 33 (1929).

Hollow tile floor construction. L. R. LOUIS. *Jour. West. Soc. Eng.*, **34** [5], 299–304 (1929).—A summary is given of the status of the flat arch type of floor construction, prepared as a preliminary to the tests now under way to establish the safe load of these floors. T.W.G.

A.S.T.M. specifications for sewer pipe and fiber strength of the material. F. B. LYSLE. *Ceram. Age*, **12** [3], 90–92 (1928); *Brick Clay Rec.*, **74** [9], 600–605 (1929); for abstract see *Ceram. Abs.*, **8** [5], 338 (1929). A.E.R.W.

City building codes. J. M. ZANDER. *Cement, Mill & Quarry*, **34** [5], 50 (1929).—Public safety, sanitation, and fire prevention are the primary reasons for building codes. A definition of "brick" comes regularly before the A.S.T.M. as propaganda. This definition would exclude everything unless made from shale, clay, or low-grade surface material dug from the ground and finally dried, and fired. Good brick are produced by the millions from sand, dug from the earth, and sand is a wonderful fireproofing material. The only official definition of brick made from low materials is the one issued by the Interstate Commerce Commission: "Common Brick are brick from low grade surface clay." E.P.R.

Standards of the German sand-lime brick industry. ANON. *Zement*, **17** [39], 1457 (1928); *Rock Prod.*, **32** [8], 97 (1929).—The standards set for the Assn. of German Sand-Lime Brick Mfrs. who supplied a demand of 500,000,000 brick in 1926 and nearly one billion in 1927, require a compressive strength of at least 150 kg. per sq. cm. (2133 lb. per sq. in.) for air-dried brick, and the water-adsorbent capacity must not be less than 10% of the weight. The brick is thus tested for compressive strength and for water absorption in respect to both weight and volume of the product. Standards are also being worked out for lime. F.P.H.

Factory design and equipment. XXII. T. W. GARVE. *Clay-Worker*, **91** [5], 408–10 (1929).—A discussion of general construction features, railroad siding laying, draining, grading, and excavating of the plant site, foundation construction, building construction features, and points to be considered in construction work during the winter are given. For previous abstract see *Ceram. Abs.*, **8** [6], 412 (1929). E.J.V.

Use of clay products. ANON. *Brick Clay Rec.*, **74** [9], 606 (1929).—Use of clay products for building would not only preserve the rapidly disappearing wood resources

of the country but would promote beauty in home building. Clay products manufacturers should conduct a merchandising campaign along this line. E.J.V.

Stimulate brick sales with mortar colors. ANON. *Brick Clay Rec.*, **74** [9], 616 (1929).—The value of mortar color as an aid in selling brick was demonstrated by the exhibit of the Common Brick Mfrs. Assn. at the American Ceramic Exposition. This exhibit, in which a new and unusual mortar color was used, led many prospective builders to seek information about common brick and figures on cost of brick construction. A complete line of mortar colors, including several unusual shades, is being produced by Colorway, Inc., Chicago. E.J.V.

Making brick in Macon. ANON. *Clay-Worker*, **91** [5], 400–406 (1929).—The Cherokee Brick Co.'s four-unit plant has been modernized, an immense clay storage has been built, and the plant is now producing large quantities of good quality face brick and other clay products. Details of plant construction are given. The products are sold through the Standard Brick and Tile Co., Macon, Ga., a selling organization which also markets the entire output of the Bibb Brick Co. E.J.V.

BOOK

Structural Clay Tile Floor Data. Published by the Structural Clay Tile Assn., Chicago, Ill. Price $3.00. This book contains more than 40 pages of tables of structural data on steel and clay tile. Reviewed in *Brick Clay Rec.*, **74** [10], 696 (1929). E.J.V.

PATENTS

Treating clayware. WILLIAM E. CRAMER. U. S. 1,709,063, April 16, 1929. Apparatus for treating plastic clayware comprising the combination of a plurality of drying units of successively increasing height, a tunnel kiln, and trackage extending through the drying units and the kiln whereby a partial setting of ware in plastic state can be sent on kiln cars through the drying unit of lesser height, additional plastic ware set upon the ware so dried, the dried and undried ware sent through the next drying unit of greater height, and the whole setting then sent through the tunnel kiln for firing.

Brick lifter. GRAFTON E. LUCE. U. S. 1,709,138, April 16, 1929. In combination, for lifting brick, a brick support, a plurality of brick arranged in tandem relation upon the support, a plurality of brick-grasping devices similarly arranged, the brick-grasping devices and the support having relative movement with respect to each other in the tandem direction, and means associated with each grasping device for actuating the same to grasp and lift the brick substantially vertically.

Brick lifter. GRAFTON E. LUCE. U. S. 1,710,096, April 23, 1929. In a lifting device the combination of a pair of oppositely acting clamping plates for clamping an article therebetween, pressure operable means, a linkage connection between the pressure operable means and the clamping plates for clamping and thereafter lifting an article when clamped, a trigger interposed in the path of the article and engageable thereby, a normally open control for the pressure operable means closable upon engagement of the trigger by the article, and means operable by the pressure operable means for elevating the trigger upwardly and outwardly from the path of the article when elevated.

Brick-setting machine. GRAFTON E. LUCE. U. S. 1,712,773, May 14, 1929. A brick-setting machine including a supporting member, a frame suspended therefrom, means secured to the frame for supporting a stack of brick means for grasping the lower course thereof and means operable by the relative movement between the supporting member and frame for actuating the grasping means.

Building blocks; columns; floors. P. LAFON. Brit. 306,134, April 17, 1929. Apertured building blocks for general construction are formed with the edges of the perforated face in the ratio 2:1, and have 8 large apertures, and several small apertures. The large apertures have a cross-section made up of various radii to preserve a nearly

uniform thickness of material; the sides have flutings for keying plaster or cement, or to form ornamentation on outside faces The apertures may form ventilation flues or may contain sound-deadening material, or reinforcing bars may be grouped in them. Half and quarter blocks may be formed from the complete block. The blocks are made from plastic material such as clay, cement, or glass.

Bricks. P. M. STEWART AND G. H. C. RATCLIFFE. Brit. 306,210, April 17, 1929. Recessed bricks are formed with one or more partitions extending transversely across the cavity to prevent sagging of the walls during drying and firing. The partitions are cut back to form a communicating space. A die for pressing the brick is furnished with a head grooved transversely to form the partitions. The head is hollow and heated by steam circulated through pipes and is attached by screws to the die plate which is, in turn, secured to the body by screws.

Molding bricks. F. BANDINI. Brit. 307,550, May 1, 1929. Wet clay, containing not less than 20% moisture, is heated to approximately 95°C and passed through an extrusion machine maintained at about the same temperature, the hot extruded material being cut into bricks which are passed directly to a drying oven and subjected to a progressively increasing temperature in a humid atmosphere until dry. In the drying oven the temperature is gradually increased from 95°C to 120–130°C and the air is kept damp, *e.g.*, by introducing hot water and limiting ventilation, to prevent too rapid drying and avoid cracking.

Brick delivery machines. A. HEIL AND C. KELLER & Co., GES. Brit. 307,598, May 1, 1929. Brick cut at right angles from a continuous bar are deposited obliquely upon frames by an intermediate member disposed between the bar and frames. The intermediate member comprises a Ferris wheel device composed of rings carrying pivoted supports which are adapted to receive the brick cut off from the bar and to deposit them upon frames which are advanced at an angle to the bar.

Molding hollow bricks. L. AVANZINI. Brit. 307,752, May 8, 1929. Hollow brick closed at one end are produced by molding a series of solid brick in a press and producing the cavities in such brick, while still soft, by means of drilling, milling, cutting, etc., tools. The brick issuing from the press may be dealt with in groups.

Refractories

Specifications and tests for refractories. ANON. *Ceram. Age*, **12** [5], 182–87 (1928).—A report is given of the New York meeting of the American Refractories Institute. A.E.R.W.

Standard test methods in America. G. A. KALL. *Feuerfest*, **5** [3], 56–60 (1929).—Standard test methods employed in the testing of refractories in America are described. These include methods developed by the Bureau of Standards, A.S.T.M., and the American Refractories Institute. F.P.H.

Specifications for refractories. L. C. HEWITT. *Fuels and Fur.*, **6** [10], 1309–1404 (1928).—Present-day purchase methods call for an increasing use of specifications. Specifications generally narrow the market because all manufacturers cannot furnish material of the specified properties. The word "service" in specification writing must mean "economical service," assuring that high-priced materials will not be used where lower-priced materials would suffice and that better quality will be used where it would be economical to do so. Refractories manufacturers would be materially aided if specifications covering the required properties for a particular service were available. Laboratory tests necessarily accelerate service conditions and true simulation is not obtained. The present trend in laboratory practice is to increase the duration of the tests which will give more reliable results. The development of any one property in a refractory to its maximum is generally accompanied by a weakening of some other property. The

specification should stress only those properties which are most essential. Temperature is usually the first consideration in drafting a set of specifications for a refractory. P.C.E. values are now used as a measure of heat resistance but this is not always reliable as the composition of the refractory may affect its behavior in service. Other factors such as resistance to slagging or spalling may be paramount. Specifications cannot be used to select one from a large number of brands, but serve only to narrow the field, eliminating those brands obviously unfit for service. Consideration must also be given to variations which are (1) different conditions existing in different parts of the same furnace and (2) variance in the operating conditions of the same furnace from time to time. Refractories are often blamed for the shorter life of furnace construction because of variations in operating conditions not set forth in the specification. The situation renders the task of specification writing difficult and indicates the desirability of closer coöperation between the engineers of the producer and consumer. Such coöperation is essential because the drawing of a specification that will be serviceable requires an intimate knowledge of the tests existing today, the service conditions to be met, and knowledge of the processing and service action of the refractory. A.E.R.W.

Physical properties of refractory clays for glass furnaces. ANON. *Fuels and Fur.*, **6** [10], 1382 (1928).—The abstract of a paper presented at a joint meeting of the Society of Glass Technology and the Deutsche Glastechnische Gesellschaft at Aachen. Tests conducted on 16 known German clay products showed that refractoriness and capability of resisting the molten materials and glass were chiefly decided by the porosity and to some extent by the composition of the clay. Clays with high alumina content generally show a considerably greater resistance to molten materials than highly siliceous clays. A.E.R.W.

Influence of temperature on the chemical and physical properties of refractory clays. ANON. *Fuels and Fur.*, **6** [10], 1412 (1928); for abstract see *Ceram. Abs.*, **7** [8], 545 (1928). A.E.R.W.

Spiral markings on silicon-carbide crystals. W. HUGHES. *Nature*, **123**, 603 (1929).—The spiral markings often found on silicon-carbide crystals are explained in the following manner. First a small crystal center is formed. The latent heat of crystallization renders the layer about it more mobile and decreases its surface tension. As a result the liquid is drawn away from the center and forms a ridge which soon crystallizes, whereupon another ring is formed. The process repeating itself forms the spiral markings or concentric rings. C.R.A.

Refractories for the pottery industry. II. Saggers. W. EMERY. *Trans. Ceram. Soc.* [Eng.], **27** [3], 169–218 (1927–28).—Data are compiled from answers to a questionnaire showing that the bulk of loss is said to be due to cracking across the bottom and up the sides of the saggers. Evidence shows that sagger loss, besides being greatly influenced by a host of factors depending upon raw materials and sagger-making, was also greatly influenced by the treatment of the saggers in the kiln, and that more than 75% of sagger loss can be avoided by the regularity of firing incident on firing with fuel-oil. For Part I see *Ceram. Abs.*, **5** [11], 364 (1926). R.F.S.

Crushing strength of unfired fireclay bodies. WALTER C. HANCOCK AND J. G. COWAN. *Trans. Ceram. Soc.* [Eng.], **27** [4], 243–46 (1927–28).—Crushing strength of unfired fireclay bodies was compared with the tensile strength. Test pieces were a mixture of two Stourbridge pot clays, ground to pass a 30-mesh sieve, and hard-fired Stourbridge clay for "grog," crushed and sieved to give two grades: (*a*) passed $^1/_{16}$-in. sieve and retained on 30-in., and (*b*) passed $^1/_8$-in. and retained on a $^1/_{16}$-in. Three forms of test-piece were employed: (1) cylinders 2 in. high by 1 in. in diameter; (2) rectangular blocks 2 x 1 x 1 in.; (3) cubic blocks 2 x 2 x 2 in. R.F.S.

Refractory material used as mortar for laying up refractories. D. A. MOULTON.

Trans. Ceram. Soc. [Eng.], **27** [4], 329–33 (1927–28).—High-temperature cements may be made from pulverized fired fire clay in the form either of scrap refractories or calcined fire clays, having chemical composition similar to the refractories. In using the scrap refractories, care must be taken not to use that portion which may have fused glass or slags attached to its surface, as this will lower the refractoriness of the mortar. By adding a colloidal material such as bentonite or acquacryptite, a suitable refractory mortar may be obtained at a minimum cost. This cement will be satisfactory if the present lining is suitable, since the additions of this type of material only lower the fusion range sufficiently to vitrify the joint at the furnace temperature. This high-temperature cement may be mixed with coarse grog to make a monolithic lining in various types of furnaces. R.F.S.

Manufacture and use of semidry-pressed refractory brick and shapes. EARL HAGAR AND L. W. FLOOD. *Bull. Amer. Ceram. Soc.*, **8** [5], 107–109 (1929).—As the semidry process is a comparatively recent development some of its advantages are enumerated. In general, the higher the percentage of moisture without any excess the better the brick. This moisture content usually runs between 7 and 10% for the best results in semidry pressing. A high percentage of plasticity is not essential since the pressure at times equals 5000 lbs. or more per sq. in. The preparation of the materials is a very important part for semidry pressing. A discussion of mechanical vs. hydraulic pressing is given. Some of the advantages enumerated include lower cost of manufacture, better workmanship, elimination of cost of handling through a drier, greater uniformity of ware, increased refractoriness, reduction of fire clay needed in joints, and poorer conduction of heat decreasing loss of heat through radiation. E.J.V.

Refractories investigation. ANON. Bur. Stand., *Tech. News Bull.*, No. 143, p. 26 (1929).—Thermal expansion data determined on fire brick "as received" from the manufacturer after reheating in the laboratory kilns at the Bureau at 1400, 1500, and 1600°C show that both the rate of expansion and total expansion of the majority of brick decrease as the temperature of firing is increased. These data also indicate that the thermal expansion behavior of the finished brick may not necessarily be the average rates of expansion of the clays entering into their manufacture. The modulus of elasticity of the brick increases greatly at 550°C when compared to values obtained at 20°C. Resistance of fire brick to spalling decreased with increase of modulus of elasticity and thermal expansion. Data were obtained which show that sufficient differences exist in the physical properties of brick of the same brand to cause large variations in the number of quenchings required to cause spalling. R.A.H.

Fire brick for kilns. ANON. *Brit. Clayworker*, **37** [443], 461–62 (1929).—The refractory material of which the kiln lining is made should be of good quality, having a refractoriness of Seger cones 29 to 30, fairly close in texture and accurate in shape. Purpose made bricks and blocks are desirable for springers in the kiln crown, flue, and wicket arches, feedholes, and grate bars. Sometimes kiln linings fail because an unsuitable mortar has been used. The most suitable mortar is a mixture of plastic fire clay and grog, made into so soft a paste that it can be poured on with a spoon. Thick pasty mortar is unsuitable. R.A.H.

Heat penetration in refractories. ANON. *Cement, Mill & Quarry*, **34** [5], 53 (1929); for abstract see *Ceram. Abs.*, **7** [5], 295 (1928). E.P.R.

Bonded refractory. RUSSELL EDMUND LOWE. *Refrac. Jour.*, **4** [43], 228 (1929); for patent see *Ceram. Abs.*, **8** [2], 127 (1929). E.P.R.

Refractory materials. ANON. *Refrac. Jour.*, **4** [43], 228 (1929); *Concrete Constr. Eng.*, pp. 35–38 (1928).—The technique of refractory materials used in cement work is discussed together with recommendations for materials suitable for low and high tem-

perature work such as for boilers and kilns. Valuable data are given relating to the physical characteristics of refractory materials. E.P.R.

Consumption of diaspore. A. F. GREAVES-WALKER. *Ceram. Age*, **12** [3], 92–93 (1928); for abstract see *Ceram. Abs.*, **8** [1], 38 (1929). A.E.R.W.

Destruction of blast-furnace brick. E. DIEPSCHLAG AND K. FEIST. *Refrac. Jour.*, **4** [43], 230 (1929); for abstract see *Ceram. Abs.*, **8** [3], 193 (1929). E.P.R.

Failure of refractories. W. LINKE. *Emaillewaren-Ind.*, **6** [9], 67–68 (1929).—A refractory must stand a temperature of at least cone 26. It is important to consider (1) refractoriness, (2) behavior against gases, ash, cinders, metals, and their oxides, and (3) resistance to temperature change. Even if all conditions are right, failure may occur along exposed edges and surfaces. It is best to use a finely-grained and dense material to overcome such surface attack. Much damage is done by quick temperature changes, usually near the doors. Repairs must be made quickly by the use of paste or replacement of the muffle. T.W.G.

Mortar for coke ovens. P. B. ROBINSON. *Feuerfest*, **5** [2], 13–15 (1929).—A good mortar for clay refractories to be used in coke ovens consists of clay, grog, and sand in the proportion 50, 25, and 25%. A useful mortar for silica brick consists of a mixture of 10% plastic clay, 30% grog, and 60% ganister. For use around gas works it is best to use a fine-ground ganister mixture containing 5% lime. F.P.H.

A modern coke oven. K. FALK. *Feuerfest*, **5** [2], 15–21 (1929).—The development of the modern coke oven is traced. Examples of the most modern types of coke ovens are described and illustrated. F.P.H.

Properties and qualifications of silica brick for coke ovens. H. KNUTH. *Feuerfest*, **5** [2], 21–26 (1929). F.P.H.

Coke ovens. G. LORENZEN. *Feuerfest*, **5** [2], 26–29 (1929).—New coke ovens made by C. Otto and Co., of Bochum are described. F.P.H.

Literature on refractory materials for coke plants and gas works. L. LITINSKY. *Feuerfest*, **5** [2], 46–49 (1929). F.P.H.

Refractory material for the Martin steel plant. O. PHILIPP. *Feuerungstechnik*, **17** [8], 91–93 (1929).—The requirements which refractories and refractory materials must meet for use in the Martin steel plant are discussed in detail. The variations usually found in silica refractories are given as follows:

Chemical composition	Minimum (%)	Maximum (%)	Usual values
SiO_2	90.5	96.5	94–95
CaO	1.25	3.75	1.5–2.0
Fe_2O_3	0.3	3.7	1.0–1.5
Al_2O_3	0.25	3.7	2.5–3.0
Cone fusion	28.29	33.34	32–33
Softening temperature under load of 3.6 kg./cm.^{2}	1460	1640	1535–1610
Specific gravity	2.32	2.60	2.37–2.52

Heat capacity of various refractory materials in cal./cm.^{3}

Temperature (°C)	Clay	Silica	Magnesia	Zirconia
100	0.400	0.349	0.621	0.470
1000	0.570	0.495	0.842	0.852

F.P.H.

Improving the service of refractories. ANON. *Fuel Econ.*, **4** [37], 45–47 (1928); *Feuerfest*, **5** [3], 64 (1929).—Suggestions are given to improve the service of refractories. F.P.H.

Properties of silica and fireclay products used in the carbonizing industries. ANON. *Gas Jour.*, pp. 65–77 (1928); *Feuerfest*, **5** [2], 37–39 (1929). F.P.H.

Lime-bonded and clay-bonded silica brick. H. ILLIES. *Iron Coal Trades Rev.*, **117,** 401 (1928); *Feuerfest,* **5** [3], 62 (1929). F.P.H.

Economy in insulating furnace arches. ANON. *Heat Treating and Forging,* **14,** 1202–1206 (1928).—The tests reported demonstrate the economy to be derived from the addition of insulating bricks to the arch of a furnace. The arch (area, 200 sq. ft.) was of 9-in. fire brick, and the insulating bricks were $2^1/_2$ in. thick; with an interior temperature of 1200°C the temperature of the outside of the fire brick was 219°C when unprotected and 645°C when insulated. Costs are given to show that the saving obtained during the life of one arch was $188.00, the life being about 10 heats each of one month's duration. (*J.I.S.I.*)

Melting plant and appliances in modern iron foundries. J. MCLACHLAN AND C. A. OTTO. *Iron and Steel Ind.*, **1,** 275–79, 319–23, 387–91; **2,** 25–28 (1928).—The authors deal with the various types of cupola and with continuous casting during the length of a blow, and also discuss the blast volume and the quality of castings. Such matters as charging the cupola, the ratio of metal to fuel, regulating the blast, and the necessity for proper temperature control when tapping are considered. Some special types of cupola, crucible, and electric furnaces, are described. Fans, blowers, and various cupola accessories are dealt with. (*J.I.S.I.*)

Brick showing brownish black stains. H. LUFTSCHITZ. *Tonind.-Ztg.*, **51,** 702–703 (1927).—L. examined a brick in which were visible, both within and without, black points, around which were a red coloration and a part fused in the form of a crater. Analyses showed that the black parts contained nearly twice as much iron as the red parts, the iron in the former being present chiefly in the ferrous state. It was not possible to determine how the enrichment of these parts in iron was brought about. (*J.I.S.I.*)

Saving heat losses by insulation. J. B. FORTUNE. *Fuel Econ.*, **3,** 763–66 (1928).—A brief discussion of the insulation of open-hearth furnaces, mixers, and soaking pits. (*J.I.S.I.*)

Highly refractory furnace linings. K. HEINRICH. *Giesserei-Ztg.*, **25,** 508–13 (1928).—The qualities required in high refractories, and the properties of artificial and natural bricks, are first discussed. The Crummendorf quartzite schists, their properties, and possible applications, are next described. The large pieces, as mined, are cut into blocks by means of heavy saws with diamond teeth attached, while the smaller pieces are ground and made into mortar and into a paste for molding into bricks. When laying the blocks care must be taken that the ends, and not the sides of the blocks cut parallel to the cleavage planes, will be subjected to the action of the fire. (*J.I.S.I.*)

Note on the arches of furnaces. D. J. DELMOTTE. *Chal. et Ind.*, **9,** 232–34 (1928).—D. discusses the causes which provoke or hasten the destruction of the arches in furnaces. (*J.I.S.I.*)

Refractories for the cupola. W. HOLLAND. *Foundry Trade Jour.*, **38,** 367–68 (1928). (*J.I.S.I.*)

PATENTS

Furnace structure. ARTHUR J. JACKMAN. U. S. 1,709,350, April 16, 1929. A furnace having a suspended arch roof comprising a layer of backing brick having hanger-receiving slots in their upper surfaces, hangers engaging the slots for supporting the backing brick, and a facing layer of nonspalling veneer brick having supporting extensions extending into the layer of backing brick and provided with supporting means engaging the backing brick at points above the points of support of the backing brick by their hangers, whereby the material of the backing brick between the points of support of the veneer brick from the backing brick and the backing brick from their hangers is under compression.

Furnace-arch construction. ENOCH P. STEVENS. U. S. 1,710,247, April 23, 1929. In furnace-arch construction, a row of brick, suspension means therefor, and compression means at an end of the row, the compression means comprising a weight and an elbow member socketed in the end brick of the row and also in the weight.

Tie member for furnace walls. CHARLES J. HANIMAN. U. S. 1,710,257, April 23, 1929. In a furnace, inner and outer walls, and a tie piece holding the walls together and having enlarged ends in rocking engagement therewith.

Laboratory muffle. EDWIN B. FORSE. U. S. 1,710,870, April 30, 1929. A heating chamber for metal recovery operations whose walls are comprised of at least two sections, one of which is of silicon carbide while the other is comprised of a refractory metallic oxide material, the latter forming that part of the structure which is more directly exposed to the action of oxidizing or easily reducible materials in the chamber, the former constituting the part through which most of the heat is transmitted to the chamber.

Furnace-wall construction. BERNHARD SCHROEDER. U. S. 1,710,901, April 30, 1929. An element for furnace-wall structure, consisting of complementary refractories each having an anchor slot at one end and a laterally reduced portion for a part of its length, the refractories being of substantially uniform length and of approximately the same width at their widest portions, the laterally reduced portion of one of the complementary refractories being toward the slotted end and of the other toward the opposite end.

Fire arch for furnaces. LYLE STOCKTON ABBOTT. U. S. 1,711,822, May 7, 1929. In a furnace arch, the combination of an arch bar having a row of longitudinally spaced horizontally extending projections on each side thereof, each of the rows of projections supporting a row of refractory tile thereon, the tile in the rows having inwardly offset portions extending from the top thereof below the lower edge of the bar, and having openings therethrough receiving the projections, the adjacent faces of the rows of tile being in contact below the bar.

Refractory. JAMES M. LAMBIE AND DONALD W. ROSS. U. S. 1,712,005, May 7, 1929. A batch mixture for forming refractory bodies, containing sufficient cyanite to counteract the shrinkage of the other ingredients during firing, the cyanite being finely divided.

Purifying aluminiferous ores. U. B. VOISIN. Brit. 306,094, April 10, 1929. Iron contained in bauxite or other aluminiferous ores is converted into and volatilized as ferric chloride by treating the ore at 150° to 500 °C with a current of gaseous hydrochloric acid. Chlorine may be added if any of the iron is in the ferrous state; alternatively the ore may first be roasted. The iron may be recovered as sulphate by washing the effluent gases with sulphuric acid, with recovery of gaseous hydrochloric acid for further use in the process.

Refractory materials. R. L. FRINK. Brit. 306,216, April 17, 1929. In the manufacture of a refractory composition by the union of a refractory body material such as sillimanite, bauxite, andalusite, etc., with bonding materials such as silica, there are added oxides and chlorides of the alkaline or rare earths, *e.g.*, zirconium, cerium, and thorium, so as to obtain in the cold state a cementing action in the mixture prior to the firing or heating action, under which the bonding materials are fused and unite with the refractory body material. The bonding materials preferably comprise in addition boron compounds, a suitable mixture being obtained by mixing 50 parts by weight of calcined silica, quartzite, etc., 30 parts of boric acid, 20 parts of magnesium oxide, and 5 parts of magnesium chloride, the magnesium chloride being dissolved in the water used to wet the mass and added to the other constituents, which are in powdered form. In making the composition 10 parts of the bonding mixture are mixed with about 90 parts of sillimanite etc., which preferably comprises a mixture of particles graded as to size. Prior to heating

the final mixture, it may be molded to the required shape, or, in the case of constructing or repairing furnace or tank walls, the mixture may be applied *in situ* and allowed to set, and the heating or firing effected subsequently. In another example, the bonding mixture comprises 40 parts by weight of ignited silica, 20 parts of anhydrous boric acid, 15 parts of magnesium oxide, 15 parts of zirconium oxide, 2 parts of sodium, biborate, and 8 parts of magnesium chloride. A degree of porosity may be imparted to the composition by adding thereto, previous to the firing, a proportion of fugitive particles, such as sawdust, wax, resin, or naphthalene, which are destroyed during the firing. In building up a furnace wall, for example, layers may be employed having varying degrees of porosity, or the porosity may vary progressively throughout the material. A finished surface may be given to the material, particularly when in shaped pieces or units, by subjecting it for a relatively shorter time to a temperature higher than that at which the firing was effected.

Furnaces. E. C. R. MARKS. Brit. 306,601, April 24, 1929. In a furnace-wall structure cooled by air currents passing between the inner firebrick wall and an outer wall, the fire brick in one course have an upright flange projecting rearwardly from the central part, and the fire brick in the next adjacent course have upright flanges projecting from opposite ends and adapted to rest upon the flanges which are each equal in width to two of the flanges. Upper and lower horizontal flanges are also provided on the brick, the upper flanges having notches while the lower flanges are cut away to form notches when they are laid in the course, these notches providing vertical air passages in conjunction with the outer wall. Horizontal air passages are formed by notches in the flanges. The front faces of the brick are comparatively thin while the flanges may decrease in thickness as they extend rearwardly.

Refractory substances. G. KNUDSEN, V. M. GOLDSCHMIDT, AND R. KNUDSEN. Brit. 307,391, May 1, 1929. The process for the manufacture of refractory building material, etc., consisting substantially of magnesium orthosilicate described in the parent specification is modified by substituting for or adding to the talc, other magnesium hydrosilicates, such as serpentine, or substances containing such. These hydrosilicates or the equivalent are heated with magnesia or other substances of high magnesia content or capable of forming the same, with or without suitable reaction accelerators, to temperatures below the melting point of magnesium orthosilicate. The serpentine may be first dehydrated, preferably at low temperatures. Other substances, binding agents and filling materials may be added such as granulated olivine, clay, kaolin, bauxite, and other aluminium compounds, iron ores, oxides, or other compounds such as magnetite and compounds of trivalent or tetravalent elements of high atomic weight such as titanium, chromium, manganese, vanadium, zirconium, yttrium, lanthanum, and cerium, The composition before being heated may be molded under high pressure, rammed, cast, or applied by spraying or painting. In an example a composition comprising 100 parts of serpentine and 90 parts of impure magnesite is heated for several hours at 1300°C.

Refractory substances. C. LEAN. Brit. 307,580, May 1, 1929. A refractory composition for lining furnaces, etc., consists of a mixture of fused refractory material, refractory plastic clay, or bauxite, and readily fusible salts soluble in water. The salts may be wholly or partly replaced by a cement which acts hydraulically. Suitably fused refractory materials are alumina, zirconia, zirconium silicate, thoria, and ceric oxide, and the salts may be sulphates, phosphates, chlorides, fluorides, or borates. In an example, a composition comprises 100 parts of ceric oxide, 20 parts of white bauxite, and 0.5 part of potassium sulphate. These are made into a paste with water and applied to the furnace lining or to finished or half-finished ceramic products by pouring, brushing, spraying, etc.

Terra Cotta

Industrial uses of stoneware. ALFRED B. SEARLE. *Ceram. Age*, **12** [6], 211–12 (1928).—Stoneware was used first as domestic pottery; later as coarse ware, such as stew jars and sanitary ware; during the last twenty years as chemical stoneware and large electrical insulators. Stoneware resembles hard-paste porcelain very closely, except in color, and can be made more cheaply and in a much greater variety of shapes. The essential difference between the two materials is chiefly the plasticity of the prepared paste, which is much lower for porcelain due to the use of china clay or kaolin. The great improvement made in the physical properties of stoneware is shown by F. Singer. The thermal conductivity of stoneware is higher than that of porcelain, a recently developed stoneware having three times the thermal conductivity of porcelain. Porcelain has greater tensile strength and electrical resistivity. Stoneware has several marked advantages over glass and earthenware and might be used more extensively for culinary and household purposes, particularly as large articles for hotels and restaurants.

A.E.R.W.

Table salt in zinc glazes. ANON. *Sprechsaal*, **62** [11], 185–86 (1929).—Due to conflicting data published with reference to the value of table salt in a zinc glaze, an independent investigation was carried out. The conclusion was reached that such salt should be omitted and calcined soda be introduced. T.W.G.

PATENTS

Waterproofing the parapet and fire walls on roofs of buildings. FREDERICK P. LUTHER. U. S. 1,710,484, April 23, 1929. Method of treating old brick parapet-tile coped walls of buildings which consists in removing the tile coping, and loose cement or mortar and applying a coating of waterproof material not only to the upright face of the wall extending upward from the roof but also over the entire top of the brick wall proper, applying over the same area to such coating a layer of fabric, applying another coating of waterproof material over the fabric, replacing the tile coping, and applying waterproofing material to the joints between the coping sections to assist the coatings to render impervious to moisture the upper surface of the brick wall proper as well as the face thereof adjacent the roof.

Flowerpot construction. JOSEPH KELSO. U. S. 1,710,878, April 30, 1929. In a flowerpot construction provided with the usual closed bottom, an annular supporting rib formed on the bottom of the pot, the rib being formed with circumferentially extending nitches, the bottom of the pot being formed with a drain opening adjacent to its edge and immediately inward from each nitch of the rib to allow the direct escape of water drained from the pot.

White Wares

Glass phase in porcelain. HOBART M. KRANER. *Jour. Amer. Ceram. Soc.*, **12** [6], 383–89(1929).—This paper discusses the probable developments taken place in porcelain during the firing and overfiring processes. Evidence is given for the belief that mullite solution in the glass may be the cause of change of characteristics of the porcelain. Observations in the clay–flint–feldspar system and in the magnesia–alumina–silica ternary are discussed in connection with the above subject.

Use of Ingersoll glarimeter in testing resistance of ceramic glazes to abrasion. PAUL SHERRICK. *Ceram. Age*, **12** [3], 101–103 (1929).—Definite quantitative grading of ceramic glazes with respect to their durability under continuous service would permit standardization of production. Tests are frequently made by subjecting specimens to sand abrasion and then comparing them with an arbitrary appearance scale or determining loss in weight. S. points out the disadvantages of these methods and describes in detail methods based on the Ingersoll glarimeter. The work of Scott and

Harrison, in which the Ingersoll glarimeter was used in finding the abrasion resistance of ceramic glazes, is reviewed. The relation between per cent loss of gloss, and weight of sand used, can be expressed by an equation containing three constants. The glarimeter readings become less accurate when the gloss is reduced by more than 10%. Although it cannot be said safely that the practical value of the method has been established, yet it appears from Harrison's figures that it is sufficiently fine to permit closer control of production than now exists. A.E.R.W.

Causes for blistering of cast ware. ANON. *Ceram. Ind.*, **12** [5], 553 (1929).—By overlooking some of the smaller details in casting installations, defective ware has resulted. Too often the rate of flow of the returning slip is given very little attention. If slip from the tail pipe falls a considerable distance into the agitator, it will cause bubbles; the amount of air thus added is considerable, and the rather viscous slip holds air tenaciously. Occasionally a slip will jelly especially if exposed to the carbon dioxide in the air. Barium compounds will retard this gelatinizing. "Tuckling" sometimes occurs in bone-china shapes, *i.e.*, the casting will remain soft for a considerable time and in certain places on the casting the clay appears to be of varying thickness. A good cure for this is to blunge with alkali to obtain maximum fluidity, and about 0.2% ammonium chloride to prevent its running back after casting. Manufacturers of semivitreous ware use borax or alum for the same purpose. Unweathered ball clay gives better results than weathered clay. In one plant one-half the ball clay was heated to about 300°C to accelerate the rate of casting. This lowered the mechanical strength of the body. Rapid filling of molds often produces a fluting or uneven surface on the ware. F.P.H.

Control of casting slip. ANON. *Ceram. Ind.*, **12** [5], 552–53 (1929).—A report is given of the spring meeting of the Ohio Ceramic Industries Assn., at Sebring, Ohio. The casting of ware with and without filter presses was discussed. It is best to standardize on one brand of sodium silicate and to have the stock solutions thoroughly mixed at all times. The silicate solutions tend to separate on standing or on cooling. If they should separate, it is best to heat them and agitate them thoroughly. An attempt is being made to correlate the hardness of the cast pieces with the casting qualities of the slip. The slip is poured into a bar mold and allowed to stand for two hours. The bar is then removed from the mold and cut into five cubes. The hardness of the pieces is determined by allowing a certain weight to fall a certain distance on the piece and measuring the amount of deformation resulting from the impact. An open discussion followed in which it was pointed out that the use of the filterpress method permitted (1) more intimate mixture of body constituents and (2) better control of the water content of the slip. This method seems to be more "fool proof" than that in which the filter presses are not used. The importance of keeping the slip warm (90°F or higher) was stressed by several members. The flocculating effect of calcium and sulphate ions derived from (1) scrap in contact with molds, (2) clays treated with the ions in the purification process or those which carry calcium sulphate as impurities, and (3) water used in the blungers, was considered to be the cause of some of the trouble experienced with the casting process. The determination of the p_H value of the slip and the use of these determinations for control of casting were discussed. It was pointed out that such determinations could be only used as an indirect control method because of the great number of other variables that influence the casting quality of slips. A more direct method is needed for slip control especially where thick ware is to be cast. F.P.H.

Moisture vs. pressure in dust-pressed ware. E. C. HENRY. *Ceram. Age*, **12** [5], 187–90(1928).—The object of the investigation was to determine the effects of moisture and pressure in the production of a typical dust-pressed electrical porcelain body. Disks having an area of 3 sq. in. were pressed at pressures from 200 to 16,000 lbs. per

sq. in. using 10-mesh dust having water contents of 0, 5, 10, 20, and 25%. The disks were dried and fired in commercial kilns to cones 10 and 11, drying shrinkage, total shrinkage, and absorption being measured. The conclusions are (1) increased pressure decreases drying shrinkage, firing shrinkage, and absorption, (2) shrinkage and absorption variations are less at higher temperatures, (3) increased moisture content increases drying shrinkage, decreases absorption at lowest pressure, and decreases variation in shrinkage and absorption, (4) at constant pressure, the moisture content determines the maximum density that can be reached. The discussion of D. P. Forst, J. M. Gilfillan, Kahn, R. H. Minton, H. P. Humphrey, C. C. Treischel, and C. F. Geiger is reported. A.E.R.W.

Florida clay in bone-china bodies. C. JACKSON. *Trans. Ceram. Soc.* [Eng.], **27** [3], 151–52 (1927–28).—The body selected consisted of 50% calcined bone, 20% Cornwall stone, and 30% English china clay. It was found that Florida clay suited this purpose very well. A body containing English china clay and Florida clay in equal amounts, has an absorption of 0.7%. Each member of the series gives a beautiful bone china. A mixture of English and Florida clay seems more desirable, as the working properties of the body are improved and the results after firing indicate a more desirable product. Nos. 3, 4, and 5, the finest samples of the series, are given.

	Parts A	Parts B	English Clay	Florida Clay
No. 3	$3^1/_2$	$1^1/_2$	9	21
No. 4	3	2	12	18
No. 5	$2^1/_2$	$2^1/_2$	15	15

Lake County clay, mined at Okahumpka, Fla., was the Florida clay used. R.F.S.

Porcelain insulator tests. B. L. GOODLET. *Elec. Rev.*, (London), **104** [2682], 715–17 (1929).—Specifications for insulators and designs based upon laboratory tests are given. T.W.G.

Maturing temperature of fritted pottery glazes. E. LEONHARDT AND E. ZSCHIMMER. *Sprechsaal*, **61** [39], 763–67; [40], 785–88; [41], 805–807; [42], 823–27; [43], 843–47; [49], 961–65; [50], 977–80; [51], 997–1001; [52], 1019–22 (1928); for abstract see *Ceram. Abs.*, **8** [4], 284 (1929). T.W.G.

Beginning of pottery industry in Ohio. R. M. KNITTLE. *Ceram. Age*, **12** [3], 120–21 (1928); *Columbus Dispatch*, Columbus, Ohio.—A description of the initiation of the pottery industry in East Liverpool, Ohio, is given. A.E.R.W.

New tile company. F. L. DRINKWATER. *Ceram. Age*, **12** [4], 142–43 (1928).—The new Pomona Tile Mfg. Co. in Los Angeles is described and illustrated. A.E.R.W.

Ohio leads in making pottery. ANON. *Nat. Glass Budget*, **44** [51], 17 (1929).—Seventy-four per cent of all pottery made in the U.S. is manufactured in the four states Ohio, N. J., W. Va., and Pa. They rank in the order named, Ohio alone manufacturing about $39,000,000 worth or more than one-third of the nation's total. E.P.R.

Imported pottery. MARGARET HARMON. *Amer. Home*, **2** [1], 14 (1929).—This is a discussion of colorful European earthenware for table use including Quimper pottery from Brittany, German blue plates, Swedish earthenware, Czechoslovakian, Spanish and Italian, as well as French Limoges and English Wedgwood. E.J.V.

Packing sanitary ware for export shipping. THOMAS E. LYONS. *Ceram. Ind.*, **12** [5], 548–51 (1929). F.P.H.

American chinaware corporation completes organization plans. ANON. *Crockery & Glass Jour.*, **107** [5], 43 (1929).—With an initial capacity of one hundred and two kilns, the American Chinaware Corp. has announced the completion of its organization in Cleveland, Ohio. Nine general ware potteries have been merged. E.P.R.

Silicosis. E. L. COLLIS. *Trans. Ceram. Soc.* [Eng.], **27** [3], 161–67 (1927–28); *Brit. Clayworker*, **38** [444], 6–8 (1929); *Ceram. Age*, **12** [4], 164–66 (1928).—Silica dust gaining access to the tissues passes into solution, and modifies the surrounding tissue so as to render it favorable for the tubercle bacillus. That silica particles pass into solution in the body fluids has been demonstrated. Animals poisoned by injections of soluble silica are found to have inflamed kidneys. These organs strive to eliminate any silica present in the blood and become inflamed. This accounts for the high death rate from chronic nephritis. R.F.S.

Pottery industry in North Staffordshire. JOSIAH C. WEDGWOOD. *Pottery Gaz.*, **54** [623], 795–98 (1929).—In 1369 a license was granted to dig clay to make pots, indicating that the potting industry was already becoming somewhat specialized in North Staffordshire. Brushwood was used as fuel until about 1600, when coal was found easily accessible. Licenses had to be obtained to dig clays. Pottery was made from local clays. At that time two types of ware were produced, one a lead ore glazed ware, the other a type of marbled ware produced by mixing clays of various colors together. In the late 17th Century the introduction of teapots brought a change in the industry. The Elers brothers produced an embossed type of ware. At about 1720 the real improvements in the manufacture of Staffordshire commenced with the introduction of white clay and casting. Various inventions such as wet grinding of flints, the throwing wheel, plaster of Paris molds, and fritted lead glaze were introduced between 1735 and 1750. The Longton end of the potteries began in 1750. The Whieldon-Wedgwood period started in 1740. In 1760 enamel decoration was introduced and women began entering the industry as decorators. Underglaze printing was invented in 1790. In 1780 the practice of making ware and selling it to another firm to market through its dealers was common. China was first manufactured about 1791, while in 1800 the three great factories of Spode, Minton, and Davenport were in the field. The introduction of machinery helped improve conditions materially. E.J.V.

PATENTS

Lavatory. WINFIELD E. HINSDALE. U. S. 1,709,131, April 16, 1929. A lavatory comprising a slab, a basin, an overflow passage behind the basin and connected therewith the overflow passage extending beneath the basin and having a bottom wall parallel with the bottom of the basin, an opening through the slab above the overflow passage, an outlet in the bottom of the basin communicating with the overflow passage, an opening in the bottom wall of the overflow passage below and in alignment with the basin outlet to receive with the basin outlet a valve for controlling the outlet, and a trap positioned rearwardly of the outlet and having its inlet leg in alignment with the overflow passage and with the opening through the slab, all in one integral structure.

Water-closet bowl support. WINFIELD E. HINSDALE. U. S. 1,709,132, April 16, 1929. Means for supporting a wall hung bowl and connecting its outlet to a horizontal opening in the waste piping, the means including in combination a carrier having a floor plate adapted to underlie the floor surface and a vertically extending portion adapted to underlie the wall and including a vertically adjustable member provided with an opening for alignment with the horizontal opening in the waste piping, a nipple adapted to pass through the opening in the vertically adjustable member and to be secured at its rear end by threaded engagement within the horizontal opening of the waste pipe, and provided adjacent the front end thereof with a flange, adjustable means connected to the vertically extending portion of the carrier adapted to be brought into contact with the rear surface of the flange, means for securing the bowl to the vertically extending portion of the carrier, and adjustable means adapted to be interposed between the nipple and the bowl outlet to complete the passage from the latter to the waste piping.

Porcelain soap dish. PHILIP MUELLER. U. S. 1,709,144, April 16, 1929. A fixture having a wall engaging portion provided with a recess open at one end and having a pocket at the other end, one wall of which recess is grooved; and a spring wall plate adapted to enter the recess with its upper end entered in the pocket and engaging the groove in the wall.

Handling porcelain ware. JOHN R. MITCHELL. U. S. 1,709,733, April 16, 1929. An arrangement for handling porcelain ware comprising in combination a table along which ware boards are adapted to travel, a plurality of stations arranged along the table at which operations are to be performed upon the ware, a plurality of independent propelling means arranged along the table, one in advance of each station, for causing the ware boards to travel up to the vicinity of each station, and independent means adjacent each station for controlling the propelling means in advance of that station.

Connector fitting for insulators. ARTHUR O. AUSTIN. U. S. 1,709,825, April 23, 1929. An insulator having a socket at one side thereof and a pin at the opposite side thereof, the pin being provided with a circumferential groove and a transverse locking member connected with the socket to engage the circumferential groove in the pin of a connected insulator.

Diverting energy from high-potential conductors. ARTHUR O. AUSTIN. U. S. 1,709,826, April 23, 1929. In combination, an insulator, a grounded support for the insulator, a conductor insulated from the support by the insulator, a member of conducting material insulated from the support and also from the conductor and forming a condenser with the conductor, and a transformer having its primary winding connected between the member of conducting material and the grounded support so that the transformer is energized through the condenser formed by the member of conducting material and the conductor.

Forming ceramic structures. JAMES M. TEAHEN. U. S. 1,710,277, April 23, 1929. In a process for manufacturing ceramic structures, the step of relatively movable supporting spaced portions of an integral ceramic structure to be freely relatively movable in the direction of shrinkage between the portions and in applying a force for urging the portions in the direction of movement.

Insulator stack. JOHN S. LAPP. U. S. 1,710,880, April 30, 1929. The combination in an insulator stack of a plurality of insulator units including connecting members, fastening bolts for securing the members together, a pair of beveled adjusting shims positioned between two of the members and having slots for receiving the bolts so as to permit relative rotation between the shims for varying the relative positions of the units and means on the shims for causing relative rotation therebetween.

Making forged insulator caps. DAVID H. OSBORNE. U. S. 1,712,900, May 14, 1929. The method of making an insulator cap, etc., which includes forging a cup with a socket portion thereon and with an annular shoulder and an annular wall at the base of the socket portion, forging a partition member with guide portions thereon, forcing the partition member into engagement with the shoulder and wall and forming a hole in the socket portion for the reception of a retaining element insertable between the guides.

Molding teapot spouts. W. COULTER AND BURSLEM PRODUCTIONS, LTD. Brit. 305,372, April 4, 1929. A press for making teapot spouts, etc., comprises a 2-part die and hand-operated coring members. The upper part of the die is mounted slidably and is lowered on to the lower part by pedal-mechanism. Manipulation of the handle advances on coring die through the medium of the pivoted sector plate and rod, and also advances the other die through a pivoted plate and rod. The die is hollow to permit the escape of the cored material. The meeting ends of the two coring dies interfit to prevent the formation of a ridge, while their other ends form the closures for

the ends of the mold. In a modified construction the coring die is straight and is guided to have a sliding movement relative to the shaping dies.

Molding teapot lids. W. COULTER. Brit. 305,383, April 4, 1929. Teapot lids, etc., are molded between a counterweighted lower die and a vertically-moving upper die furnished with laterally-sliding knob-shaping members advanced by cams against the action of springs during the descent of the upper die. After the pressing operation, counterweight raises the lower die in the cylinder so that it follows the retracting movement of the upper die until the knob-forming members have been withdrawn but in some cases springs may be used instead of a counterweight. The upper die is raised and lowered by screw mechanism and carries an interchangeable member for shaping the top of the knob. The central part of the lower die can be raised by a pedal to present the molded article for delivery. The cams may be adjustable. An air vent admits air through the valve during the separation of the dies.

Electric insulators. PORZELLANFABRIK HENTSCHEL AND MÜLLER. Brit. 305,895, April 10, 1929. An electric insulator comprises a body part formed with a pin cavity which is lined with elastic material. A headed pin is held in the cavity by ring segments which are passed up the insulator neck along the pin into the cavity, a sleeve being then passed up the pin to spread the segments apart. A lead seal secures the parts in position. In a modified construction, the segments are made hollow to form an elastic support for the pin, and may be filled with soft metal such as lead. An elastic ring, pushed along the pin behind the sleeve may be used as a retaining piece until the seal is applied.

Water closets. S. PITT. Brit. 306,639, April 24, 1929. A water closet comprises a basin pivotally supported in a pedestal eccentric to its central axis, means being provided whereby the raising of the seat may tilt the basin and open the flushing valve, and its subsequent lowering permits the return of the basin and valve to their initial positions. A flexible member is connected at its opposite ends to the seat and to a pulley on a spindle, means being provided so that, when desired, the seat may be moved without effecting motion of the flexible member. Normally, however, the lifting of the seat turns the pulley to tilt the basin. Simultaneously a pin is moved to contact with a shoulder on a tumbler weight and throw it over to turn a spindle to open a flushing valve.

Insulators; suspension devices. F. A. HILL AND DOULTON & CO., LTD. Brit. 306,742, April 24, 1929. A suspension or anchoring device more particularly for suspending electric conductors comprises a number of nonmetallic members having metallic links attached at each end, the links of adjacent members being formed with mutilated interlocking parts. Insulators comprise porcelain disks each having a central upstanding boss and a socket beneath. Cemented to each boss is a metal cup, and within each socket, a bush. The cup is provided with a stem formed with radial sectors, the underside and all edges of which are rounded. The bushes are formed with corresponding sectors with cupped sockets, and inwardly tapered. Split rings locked by screws retain the members in position. To connect the chain of insulators to the tower arms and cables, respectively, the uppermost stem engages with sockets formed in a metal terminal bush integral with lugs for receiving an eye or hook, while the lowermost socket is engaged by a pin similar to the pins carrying a terminal eye to support the cable.

Molding pottery. W. COULTER AND BURSLEM PRODUCTIONS, LTD. Brit. 307,182, May 1, 1929. Perforated cup-shaped articles of pottery, *e. g.*, coffee strainers, are formed by a pressing-mechanism involving a series of pins, etc., slidably associated with the male die and actuated by link mechanism coöperating with a stop on the female die which advances the pins relatively to the associated die during the actual pressing operation. The male die is furnished with pins attached to a head which is connected by a

link to a lever having its end normally depressed by a spring. The female die is fixed and is fitted with a loose bottom apertured in alignment with the pins and adapted to be raised by rods to eject the molded article. In operation, the die is raised and the mold is charged with clay dust. Upon descent of the die to shape the article, the pins are advanced through the material by a stop on the die engaging the end of the lever.

Electric insulators. J. E. POLLAK. Brit. 307,647, May 8, 1929. The body of a lead-in insulator is formed with an annular channel along the part which is surrounded by the supporting flange, and the inner surface of the channel has a conducting coating which is connected electrically with the supporting flange. The space between the flange and the insulator body reduces the formation of corona at the junction of the flange and the body, and it also reduces the risk of breakdown by puncture. The same construction may be applied to the junction between the insulator and the lead-in conductor.

Equipment and Apparatus

Temperature control. A. M. STOCK. *Ceram. Age*, **12** [3], 94–95 (1929).—S. points out the importance of thermostats, recording instruments, and automatic temperature controls in industrial work, and describes the principles of construction and operation of the following types of temperature measuring equipment: (1) Low temperature equipment: expansion pyrometers, liquid thermostats, liquid pressure pyrometers. (2) High temperature equipment: cones, thermo-electric pyrometers, base and noble metal, resistance pyrometers, radiation pyrometers, and optical pyrometers. Automatic control should be applied much more extensively to tunnel kilns. A.E.R.W.

Use of the microscope in heat treatment. H. M. BOYLESTON. *Fuels and Fur.*, **6** [10], 1377–82 (1928).—B. reviews the development made in the field of microscopic study in the last 36 yrs. and shows the rapid strides that have been made in the development of apparatus, technique, and materials. The importance of high-power micrography and its influence as a guide in all heat-treating processes is pointed out. A.E.R.W.

Automatic temperature control for industrial heating apparatus. A. N. OTIS. *Fuels and Fur.*, **6** [10], 1387–98 (1928).—O. describes temperature control equipment now used and discusses recent installations. A.E.R.W.

Practical pyrometry. ANON. *Fuels and Fur.*, **6** [11], 1580 (1928).—(The abstract of a paper presented by Broods and Simcox at the meeting of the Institute of Metals, Liverpool, England.) Temperature indicators may be protected from magnetic effects by shielding with soft iron plates. Suggestions are offered for protecting the couple from gases and molten materials and insuring more accurate readings. A.E.R.W.

Thermo-electric measurement of high temperatures. H. L. WATSON AND H. ABRAMS. *Fuels and Fur.*, **6** [12], 1741–42 (1928).—(The abstract of a paper presented at the meeting of the American Electrochemical Society, held at Charleston-Huntington, W. Va.) A practical thermocouple for use at high temperatures was developed. It consists of a graphite tube with a tungsten rod along its longitudinal axis passing through a graphite or tungsten plug at the hot junction, and an insulating bushing at the other end, the tungsten being under tension. The cold end may be provided with a water jacket to insure constant temperature, or fitted with a specially designed head which allows the cold junction to vary from 0 to 175 °C without materially changing the reading of the couple. Leads to a millivoltmeter are made from the jacket or head. The graphite element is protected from oxidizing atmospheres by surrounding with a refractory sheath of larger bore, the annular space being filled with carbonaceous material. The sensitivity of the tungsten-graphite couple is approximately twice that of Pt Pt-Rh at 1000

to 1450°C. Thermocouples of this type have been in continuous operation for weeks, and show little or no variation from the original calibration. A.E.R.W.

Drying china clay with pulverized fuel. ANON. *Brit. Clayworker*, **38** [444], 21 (1929).—The kiln discussed is located at Burngullow, Cornwall and is 300 ft. long. It is substantially built of concrete lined with fire brick, and roofed with asbestos. The pan of the kiln measures over 300 ft. and is 17 ft. wide. The furnace end of the kiln has been specially constructed to burn pulverized coal. The heat is conveyed the whole length of the kiln pan through eleven parallel flues, each flue running the full length of the pan on which the clay is spread for drying. The temperature of any portion of the pan can be varied at will within limits and the concentration or variation of the temperature over any particular area of the pan is a factor of considerable importance. R.A.H.

Some experiments in drying clay. R. S. TROOP. *Trans. Ceram. Soc.* [Eng.], **27** [4], 303–19 (1927–28).—The experiments show that the effect of methods of manufacture on the contraction and distortion of clay bodies is undoubtedly considerable. The importance which these experiments indicate is to be attached to the "critical point" and to the changes which occur at that point, a study of the relationship between the grain size of clays and similar material and the moisture content at the "critical point" is called for. The experiments which have been made further indicate many advantages which are to be obtained from the use of humidity drying. R.F.S.

Incandescent lamp cleans blackening from inside bulb. ANON. *Amer. Glass Rev.*, **48** [28], 25 (1929).—A practical method for removing the black deposit from the inner surface of high-powered incandescent lamps has been announced by the General Electric Co. The discovery will benefit aviation and motion picture production, where high-powered and high-efficiency incandescent lamps are of vital importance. A tablespoonful of coarse tungsten powder is placed inside the lamp before sealing. When blackened from use invert the lamp and "sweep" the filament deposit off the inner glass surface restoring its former efficiency. The filament may now be heated much nearer to its melting point, without endangering the bulb and without shortening the customary 100-hr. life. E.P.R.

Advances in machinery design. ANON. *Cement, Mill & Quarry*, **34** [5], 63–64 (1929).—Vibrex screen is designed for fine materials. The vibrating element is centrally located, hence there are no dead spots. The stroke of vibration may be varied for the most efficient separating action for various size openings. E.P.R.

Hoppers for coal or clay. ANON. *Brit. Clayworker*, **38** [444], 18–20 (1929).—Concrete hoppers show up badly when given full consideration in every phase of construction, costs, and efficiency. Steel tipping hoppers are best. The construction of concrete and steel hoppers is discussed. R.A.H.

Counting machines. ANON. *Brit. Clayworker*, **37** [443], 462 (1929).—Illustrations of two instruments made expressly for service in clayworks are described. The one counter is intended for shaft revolutions or for cutting-off table operations. The other and larger instrument is intended for use on the clay hoist tracks to count and record the number of clay wagons hauled up. These machines are supplied by the Deutsche Ton und Ziegel Zeitung. R.A.H.

New screening device. ANON. *Ceram. Ind.*, **12** [5], 580 (1929).—A new type of screening device has recently come to notice in the form of a centrifugal screen. The fluid to be screened is fed into a funnel at the top of the machine and flows down through an opening in the center of the funnel, coming in contact with the upper part of the rapidly moving, revolving spray head. Due to centrifugal action, the fluid is immediately converted into a fine spray and projected through a screen. Not all of the fluid thus sprayed passes through the screen, but a considerable part of it by running

spirally downward on the inside of the screen, washes all the coarse material, which is eliminated into the residue tank, and from here the still screenable part of fluid is pumped up by the cone and sprayed through the screen. In this way, all fluid is screened by both parts of the spray head and flows very rapidly in the annular canal which surrounds the screen into the discharging spout. This screen will handle from 1000 to 2500 gal. per hr., depending upon the viscosity of the fluid and size of the mesh employed. It is made entirely of aluminum and equipped with a 1-H.P. ball-bearing motor, running at a speed of 1800 r.p.m. F.P.H.

Constructing air heaters. HARRAEUS. *Feuerungstechnik*, **16** [24], 277–78 (1928). F.P.H.

Auger machines. PAUL C. GRUNWELL. *Brick Clay Rec.*, **74** [10], 664–67 (1929); see also *Ceram. Abs.*, **8** [2], 113–14 (1929). E.J.V.

Direct-current cam switch. ANON. *Amer. Glass Rev.*, **48** [30], 14 (1929).—The General Electric Co. announces a new direct-current cam switch. E.P.R.

Chemical plant equipment. C. E. S. PLACE. *Chem. Markets*, **24**, 499–503 (1929).—Centrifuges, autoclaves, grinding, sieving and mixing machines, rough crushers, and acid-handling equipment are discussed. H.H.S.

Aging of thermo-elements. H. LENT AND F. KOFLER. *Arch. Eisenhüttenw.*, **2**, 173–76 (1928).—The object of the investigation was to discover which thermo-elements would show the least loss of thermal force combined with greatest durability. Elements composed of wires were used as follows: (1) Chronin-Konstantan; (2) Chronin V2A-steel; (3) Chronin NCT 3; (4) Chronin-Cekas; (5) Chronin-Nickel. The analyses of the wires were as follows:

	Nickel %	Chromium %	
Chronin	83.7	14.7	
V2A	8.0	15.7	
Cekas	59.7	11.2	2% Mn
Konstantan	43.0	56.3	
Nickel	98.90		
NCT3	17.5	37.6	0.48% Mn

These elements were tested for long periods in coke-oven gas at 850 to 950°C, and in tyre reheating furnaces fired with blast-furnace gas at temperatures of 850 to 900°; while others were exposed for two weeks in the waste gas flue of a set of gas-fired soaking pits. The loss of thermal force, if any, was noted, and where such loss occurred, it was found after long trials that this was not due to a change in the resistance of the heated elements. The losses varied in amount, but were greatest in the case of elements exposed to coke-oven gas. The chronin-nickel elements showed no loss in thermal force, but after long exposure the metals became coarsely crystalline, and tended to brittleness. (*J.I.S.I.*)

Test kiln for the determination of refractoriness. A. N. SYSSOJEW. *Sprechsaal*, **61** [41], 807–808 (1928).—A new and improved test kiln modeled after the Deville kiln is described and illustrated. T.W.G.

PATENTS

Drier rack frame construction. JULIUS JUDELSON. U. S. 1,709,352, April 16, 1929. A drier having a cabinet, a carrier, and drier frame mounted to reciprocate in and out of the cabinet, the carrier and frame comprising a rigid structure held in assembled position by quickly disengageable means, the means consisting of complementary portions on members of the carrier and frame in interlocking engagement with each other.

Dust classifier. HARLOWE HARDINGE. U. S. 1,709,848, April 23, 1929. The combination of an outer cone and an inner cone relatively movable and so related in respect to one another as to allow a current of material-laden fluid to flow between their

respective surfaces, the inner cone being open at the top and having disposed thereat in definite relation with the outer cone a set of deflectors of twisted configuration for controlling the whirling effect of the material-laden fluid passing therethrough, and the outer cone having an opening at the bottom for the entrance of material-laden fluid and an exit at the top for the expulsion of the fine product suspended in a current of fluid after the coarser material has been extracted therefrom by the whirling action of the material-laden fluid passing through the deflectors.

Sandblast device for controlling direction of abrasive stream. FOSTER J. HULL. U. S. 1,710,166, April 23, 1929. In an abrading machine having a rotary barrel with an opening in the axial end, a casing having an opening opposite the end of the barrel, a nozzle directed into the opening in the barrel and having a discharge end adjacent the opening, the size of the opening approaching closely the corresponding transverse dimension of the nozzle, a support for the nozzle closing the opening in the casing, and means for securing the support to the casing to various positions of adjustment in a plane transverse to the axis of rotation of the barrel providing for change of location of the nozzle, and means for securing the nozzle to the support in various angular positions providing for adjustment of the nozzle as to direction.

Sandblast barrel. FOSTER J. HULL U. S. 1,710,167, April 23, 1929. In a sandblast machine, a rotary barrel having an axial opening at the end to admit the sandblast, means directing the sandblast through the opening, the means being adjustable to determine the direction of the blast and the opening being substantially larger than the directing means to permit such adjustment, and an annular abutment surrounding the opening to deflect the articles being abraded therefrom.

Sandblast abrasive reclaiming and mixing. FOSTER J. HULL. U. S. 1,710,168, April 23, 1929. The combination with a sandblast apparatus of a tank, a mixer having a sand chamber connected to the bottom of the tank at the side, a sandblast line below the chamber and a passage leading downward from the sand chamber to the sandblast line intermediately of the latter, a supply of air under pressure and means connecting same to one end of the sand line, a sandblast nozzle and means connecting the same to the other end of the sand line, the mixing chamber having an opening at the top in alignment with the downward passage and means for closing the same whereby the downward passage may be cleared without disconnecting the mixer from the tank.

Sandblast machine for applying pressure to abrasives. FOSTER J. HULL. U. S. 1,710,169, April 23, 1929. In a sandblast apparatus, means for applying fluid pressure to the abrasive comprising a tank having primary and secondary chambers, a valve and passages providing for and controlling the admission of abrasive to the primary chamber and from the primary to the secondary chamber, means for maintaining a supply of air under pressure and an air pressure passage delivering air into each chamber, a separate exhaust passage leading from the primary chamber, the pressure and exhaust passages being spaced apart where they enter and leave the tank and having a portion in common providing a pressure and an exhaust seat, valve means coöperating with the seats and automatic means operating the same for controlling the inlet and exhaust passages to and from the upper chamber maintaining continuous pressure and a supply of abrasive in the lower chamber and means excluding the pressure air from the exhaust passage and the exhaust air from the pressure passage leading to the primary chamber.

Sandblast barrel loading. FOSTER J. HULL. U. S. 1,710,479, April 23, 1929. In a sandblast barrel apparatus, a barrel, a casing having a door opening exposing an upper portion of the barrel, a door covering the opening, the casing having an abutment adjacent the door opening, a dumping skip for filling the barrel, the dumping skip having means coöperating with the abutment, means for suspending the skip in unbalanced condition and bringing it into engagement with the abutment, the suspension

means comprising a lock to hold the skip in nondumping position, and means for throwing the lock whereby the skip is dumped through the opening into the barrel which is provided with a filling opening which may be brought into registration with the casing door opening for this purpose.

Sandblast machine. GEORGE C. FATSCHER AND CLARENCE E. BILLINGS. U. S. 1,710,612, April 23, 1929. A rotary sandblast barrel having at one end a rotary elevator drum, a stationary closure head for one end of the drum, an external pressure blast tank having a collecting hopper, a chute passing through the closure head for delivery to the sand-collecting hopper of an external pressure tank, and means carried by the drum for lifting and discharging to the hopper spent sand led to the drum from the barrel in combination with blast nozzles adapted to play through the opposite ends of the barrel upon a charge within the latter, and connections from the nozzles to the pressure tank.

Pulverizing apparatus. FRED H. DANIELS. U. S. 1,711,044, April 30, 1929. A pulverizing apparatus comprising a casing having an inlet for coarse material and an outlet for the pulverized material, means forming two pulverizing zones adjacent the inlet and outlet, respectively, which are peripherally connected, beaters in the outlet zone to pulverize the material finely and hammers mounted to revolve in the inlet zone, which coöperate with the surrounding casing wall to crush the material preliminarily, the space outside of the hammer path communicating directly with the peripheral passage connecting the two pulverizing zones whereby the material crushed preliminarily may pass freely to the second zone.

Drier. WILLIAM T. MORIN. U. S. 1,713,237, May 14, 1929. A drier comprising in combination a structure having a drying chamber with fixed flues in the walls thereof, the flues conveying hot gases, means to pass material to be dried down through the chamber but out of contact with the flues, such material being subjected directly to heat of radiation from the flues, and means to selectively pass the gases up through the material or pass the gases to a heat interchanger and pass the hot air from the heat interchanger up through the drying chamber to subject the material to heat of convection.

Molding and decorating tile. J. M. ESCOFET. Brit. 306,762, April 24, 1929. An automatically-operating plant for making decorated tile is arranged with two parallel mold-conveying tracks between which the molds are transferred as necessary. The pressed molds are ejected three at a time, to the stations by laterally-acting mold-charging mechanism and then are moved intermittently by ratchet mechanism. The mold lids are raised and carried laterally by the conveyer past a cleaning mechanism for depositing in other molds about to enter the press, while the walls are lifted and carried by the conveyer past cleaning and lubricating mechanism for redepositing on the mold bases. The tile is gripped, raised from the base, and turned through a right angle so as to be presented edge-on for delivery by hand. The mold base is brushed and rubbed before the walls and base are reassembled. A stencil is placed in the mold, and colors are poured in which are distributed by vibration, the stencil being removed for re-transference through a washing tank. The main body materials of the tile are added, while the mold lids are applied prior to the entering of the press. The molds are fed laterally into the press in groups of three. In the press the upwardly-moving rams lift the carriers off the tracks before applying the pressure, no pressure being transmitted to the supporting-legs and the balls during the pressing operation. Division plates for simultaneous manufacture of a number of tile may be fitted in each mold. The opened frames and division plates are raised by conveyer chains, furnished with cross-members having depending hooks which engage the flanges of the frame. Brushing and lubricating devices are passed upward through the mold frames. The top mem-

bers are raised by hooks on a second conveyer which transport them laterally past rotary cleaning brushes to the parallel track and re-deliver them to the filled molds about to enter the press. After the mold frame and top member have been removed in turn, the pressed tile is gripped by the lifting-tongs which are opened momentarily against the action of a spring by the depression of a plunger actuated by a projection on the carrier. One arm of the tongs engages before the other so as to move the tile laterally on the base plate to free it. The gripped tile is rotated until released edge-on for removal by hand. The vibrating-mechanism, for distributing the colors applied to the stencil, comprises a cam intermittently operated. The stencil is removed from the mold and transferred through a water bath back by a tilting track.

Kilns, Furnaces, Fuels, and Combustion

Stoker application to the car tunnel kiln. C. B. HARROP AND HOWARD S. ORTH. *Jour. Amer. Ceram. Soc.*, **12** [6], 406–409 (1929).—Arguments for use of mechanical stoker on continuous kilns are given, and the first practical application of mechanical stoker to the car tunnel kiln used for ceramics and results are described.

Symposium on tunnel kilns. TITUS SEARSON. *Refrac. Jour.*, **4** [43], 202–16 (1929); *Pottery Gaz.*, **54** [623], 786–87 (1929); *Brit. Clayworker*, **37** [443], 454–60 (1929).—Particulars of constructional details and records of performances of the Robertson, Dressler, Woodall-Duckham, Williamson, and "E.I.C.T." types of tunnel kilns. Ease of control and lack of complications, absolute control of the three main temperature zones, preheating, firing and cooling, and the absence of any direct flame impingement upon the goods being fired were emphasized as special features of the Robertson kiln. The Dressler kiln was one which had been reconstructed with a novel soaking zone between the heating and cooling zones of an ordinary Dressler so as to render it suitable for dealing with an output of 300 T. of fire brick per week, the brick in question containing a high percentage of carbonaceous matter and having to be fired to at least cone 14. The Woodall-Duckham circular type kiln was described. From the finest eggshell china to the heaviest piece of refractory fire clay, whether glazed or unglazed ware, can be fired in the Williamson downdraft intermittent kiln, which is an attempt to combine the advantages of tunnel kiln firing with the downdraft and chamber type kilns. The "E.I.C.T." kiln is being used at Baudour, in Belgium, for the firing of refractory goods of varying sizes, from normal fire brick to tank blocks having dimensions of 39 x 14 x 12 inches, the temperatures ranging between 1300 and 1400°C. The tunnel kiln offers a big variety of advantages over the old periodic kilns. E.J.V.

Tunnel kiln for firing pottery. J. WILLIAMSON. *Trans. Ceram. Soc.* [Eng.], **27** [4], 290–98 (1927–28).—This kiln differs in many respects from the usual type of tunnel kilns. It may be fired by gas, oil, or by coal burned on open grates. It is of the combined direct flame and muffle type; but instead of the flame travelling down the oven in a longitudinal direction, as is usual in tunnel kilns, it takes a transverse course which may be updraft or downdraft. The flame may also alternate from one side of the kiln to the other, so that every part of the truck on which the goods are placed is licked by the flame, thus resulting in regularity of temperature. The kiln consists of four zones, heating, equalizing, furnace, and cooling zone. The equalizing zone consists of a double-vaulted chamber or muffle which completely encircles the truck, and is constructed of fire brick of honeycomb section, inside and out, so as to present a large surface for absorbing the heat from the gas on one side, and to radiate as much of this heat as possible to the ware on the other side. The object of the equalizing zone is to avoid the drop in temperature which would otherwise exist as the direct flame enters the muffle unless other means were taken to reheat the products of combustion. Special attention has been given to the cooling of goods with air, by direct or indirect contact.

By a system of recuperators, arranged on each side of the kiln, a supply of very hot air can be passed onto the burners and the surplus air can be used for drying purposes. R.F.S.

Kilns and kiln firing. S. R. HIND. *Trans. Ceram. Soc.* [Eng.], **28** [1], 26–52 (1929).—Detailed information is given on a large number of representative kilns to arrive at possibilities of further fuel economy. Many additional tests were carried out on kilns for firing refractory materials and pottery. The greatest value of the information collected lies in the accumulated numerical data. R.F.S.

Electric tunnel kiln for porcelain. ANON. *Chem. Fabr.*, **10,** 117 (1929).—Heretofore an electrically heated muffle kiln has not been a practical success since by convection alone sufficient heat is not recovered through the muffle. This difficulty has been overcome in a tunnel kiln constructed at Gustavburg, Sweden, where the whole kiln consists of one muffle. The firing is done by radiated heat from the ceiling, which is made of silicon carbide. The cross-section measures about 30 x 40 cm. and the length 30 m. Bone china is fired. Two women, one at each end of the kiln, take care of the continuous operation. The cost per kw. hr. is 3 pfennig (75¢). T.W.G.

Gas-heated furnaces. C. M. WALTER. *Chem. and Ind.*, **48,** 404–405 (1929).—The thermal capacity of a furnace should be related to the class of work to be dealt with and also to the question of continuous or intermittent use, since an intermittent furnace of too great capacity would cause waste of time and heat in bringing it to the required temperature. The first essentials of efficiency are the admittance of only the theoretical amount of air and its complete admixture with the gas before combustion. Furnaces of the muffle and inflame type are described. H.H.S.

Gas-fired furnaces. W. M. HEPBURN. *Ceram. Age,* **12** [4], 145–46 (1928).—The important factor is not cost of fuel but efficacy of the control equipment. Furnace problems are complex and difficult to analyze. The diaphragm burner in which an explosive mixture of gas and air is forced through a porous refractory is an interesting development whose application has been limited. The use of refractory beds is more common. The temperature distribution can be made uniform and the energy radiated varies as the fourth power of the temperature. Close control is possible. Flame radiation is becoming more and more important. Automatic, continuous furnaces have resulted from studies of refractories, insulation, and alloys. The alloy belt type is used as an example. Gas permits the best control. Single-valve, gas-air proportioning controls working on Venturi principles enable the combustion to be synchronized with other automatic devices on the furnace. The analysis of each problem must be based on experimentation. Specifications for refractories, etc., are being developed which aid materially. A.E.R.W.

Fuel-fired industrial furnaces. W. C. BUELL. *Fuels and Fur.*, **6** [12], 1713–20 (1928).—The various characteristics of the different fuels are discussed in detail. A.E.R.W.

Economic consideration of industrial furnace efficiency. J. H. HERRON. *Fuels and Fur.*, **6** [10], 1370 (1928).—The determination of accurate costs of furnace operation involves many intangible factors which are difficult to determine. The principal factors affecting these costs are, (1) loss of heat in the waste gases, (2) loss due to excess air for combustion, (3) loss of heat around door openings and during the charging and discharging periods when the doors are open, (4) conduction of heat through the walls, top, and bottom of the furnace with subsequent radiation from the outer surfaces, and (5) storage of unavailable heat. Regenerators and recuperators are widely used to reduce loss of heat in the waste gases. Proper insulation materially lessens the heat loss due to conduction through the walls. Some semi-refractories are available which

have insulating properties and should receive consideration especially in low-temperature installations. A.E.R.W.

Improved Simplex kiln. ANON. *Ceram. Age*, **12** [4], 146–47 (1928); for abstract see *Ceram. Abs.*, **7** [11], 779 (1928). A.E.R.W.

Firing periodic kilns. O. TIPPMANN. *Sprechsaal*, **61** [36], 707–709; [37], 725–27 (1928).—The relation of CO_2, CO, temperature, and time in firing is discussed. Diagrams and calculations showing how the manipulation of firing and the type of furnace may increase thermal efficiency are included. Inclination between 50 and 60° of grate bars for badly clinkering coal and for slightly clinkering coal between 30 and 40° is recommended. Coal with high easily fusible ash content should not be used in a combined inclined and horizontal grate furnace. A horizontal grate furnace will show thermal efficiency. A twin furnace has no advantage. Gains are made by mechanically controlled firing, and the use of the old Y-furnace is advocated. T.W.G.

Extending Hoffman kilns. ANON. *Brit. Clayworker*, **38** [444], 15–16 (1929).—Many Hoffman kilns in England have the defect of being too short in the firing canal. Greatly improved working would be obtained by lengthening the canal. If it is desired to increase output too, a lengthening is essential and by adding additional chambers the increase can be obtained by relatively low cost. Four sketches are given showing what may be accomplished in altering kilns of various dimensions. R.A.H.

Heat balances of periodic kilns. CARL LOESER. *Sprechsaal*, **62** [5], 76–78 (1929).—A critical discussion and résumé of previously published methods of heat balancing are given. T.W.G.

World's largest coal distillation plant. H. B. CRONSHAW. *Chem. News*, **138**, 276–77(1929).—The largest low temperature distillation plant is now being erected at Glenboig, Scotland, for the Bussey Co., as the outcome of several years' experience of two full sized units at Louisville, Ky. From 600 T. of coal per day it will make 400 T. of smokeless fuel, 15,000 gal. of crude oil, and 15,000,000 cu. ft. of gas. H.H.S.

High-and-low volatile coal for periodic kilns. L. C. BOSLER. *Ceram. Age*, **12** [4], 144–45 (1928).—The price of anthracite coal having become prohibitive, bituminous coal of either high-volatile or low-volatile classification is used. The volatile matter of low-volatile coal is under 20%; of high-volatile coal, 20 to 55%. Any coal can be efficiently and smokelessly burned if sufficient heated air is admitted over the fire to consume all the volatile matter. High-volatile coals emit a large portion of the volatile matter in a comparatively short time and in the usual fire box complete combustion cannot be obtained. Raw coal is burned in periodic kilns in two steps: (1) coking at front of fire box, (2) burning of coke at back of fire box. The importance of these steps is pointed out. The consumption amounts to $^2/_3$ of the volatile matter and 78% of the coke in low-volatile coal, and $^1/_2$ the volatile matter and 55% of coke in high-volatile coal; therefore, the consumption of low-volatile coal is 17% less than high-volatile coal for the same work. Since the initial costs are equal, low-volatile coal is to be preferred. A.E.R.W.

Elimination of swelling in determination of coal-ash fusion points. S. S. COLE. *Fuels and Fur.*, **6** [7], 950 (1928).—Bloating of the sample in coal-ash softening temperature determinations has caused considerable difficulty. C. found bloating was caused by too low a furnace temperature in preparing the ash from the original coal sample. Pyrometric cones are used in the furnace and the sample is found to be right when cone 011 has touched down. A.E.R.W.

Powdered fuel in metallurgical work. W. O. RENKIN. *Fuels and Fur.*, **6** [11], 1557–58 (1928).—(The abstract of a paper presented at the World Power Conference, London, England. Oct. 1, 1928.) The use of pulverized coal in metallurgical work results in the reduction in fuel cost per ton of material treated; reduction in first cost

of furnace installation; reduction in cost of furnace maintenance; reduction in upkeep and repairs on equipment, due to better heating; reduction in metal loss in furnace; increase in tonnage produced; reduction in labor of firing furnaces and clearing ashes; elimination of deleterious additions of carbon and sulphur to the material being produced; elimination of the smoke nuisance; and conservation of fuel resources. A.E.R.W.

New methods of firing with powdered coal. WINTERMEYER. *Feuerungstechnik*. **16** [23], 265–67; [24], 279–83 (1928). F.P.H.

Various methods of gas purification especially blast-furnace gas. H. ILLIES. *Feuerungstechnik*, **17** [1], 1–7 (1929). F.P.H.

Normal combustion velocity of nitrogen-free generator and blast-furnace gas. H. PASSAUER. *Feuerungstechnik*, **17** [1], 7–8; [2], 15–21; [3], 28–31 (1929). F.P.H.

Gasification of coal by pure oxygen. J. GWOSDZ. *Feuerungstechnik*, **16** [21], 241–46 (1928). F.P.H.

Gasification of lignite. J. H. HRUSKA. *Fuels and Fur.*, **6** [7], 907–908 (1928).—Difficulties are met in trying to use modern gasification equipment with lignite. H. includes two tables showing data obtained on a recent test and analyses of the gases obtained from several lignites whose analyses are also given. The most economical results have been obtained by European producers by the use of 0.4 to 0.7 of a lb. of steam per lb. of gasified lignite. A.E.R.W.

Blending for steam generation efficiency. ANON. *Chem. News*, **138**, 275–76 (1929).—Attention is now being given to the science of blending fuel in order to reduce cost and prevent black smoke. As an example, the cost of evaporation of 10,000 lbs. of steam per hr. with 2 parts of coal to 1 part breeze was $1.68, while for 1 : 2 it was $1.44, and for 1 : 3 , $1.38. Many other materials, such as residues from the manufacture of tannic acid, alkaloids, perfumes, foodstuffs, etc., may be similarly used. H.H.S.

BOOKS

Electric Furnaces. JEAN BILLITER. (Technical Electrochemistry, Vol. 4.) 302 pp. Wilhelm Knapp. Halle (Saale), 1928. Price 19.50 R.M. Reviewed in *Feuerfest*, **5** [3], 63 (1929). F.P.H.

Coal in South Africa. ANON. *Nature*, **123**, 506 (1929).—The Geological Survey of the Union of South Africa has published the third volume of The Coal Resources of the Union of South Africa, as Memoir, No. 19 of the Survey. C.R.A.

PATENTS

Pottery kiln. ALBERT C. WARD. U. S. 1,710,558, April 23, 1929. In a pottery kiln a plurality of rows of supporting tiers arranged in circular formation in spaced relation, with the tiers of each row being staggered with respect to the tiers of the adjacent row, a plurality of radially extending flues extending transversely of the rows of tiers and separating the tiers into groups, the flues having transverse passages formed therein communicating with the groups of tiers at each side of the flue whereby to provide for the free circulation of air between the groups and a floor supported upon the tiers and the flues comprising a sub-floor section and an upper floor section, the sub-floor section being composed of a plurality of associated units arranged in circular formation with their inner and outer edges resting upon two or more tiers of adjacent rows and the main floor section being composed of a plurality of units have their edges disposed angularly with respect to the edges of the sub-floor section.

Continuous-tunnel kiln. TAINE G. MCDOUGAL. U. S. 1,710,995, April 30, 1929. In a continuous tunnel kiln for firing ceramic ware, having a zone of graduated heat treatment in which the ware is subjected to the direct action of hot combustion gases, means for transporting ware through the kiln, being arranged in substantially single tier formation, the tunnel having substantially unbroken uniplanar walls throughout

the zone, the means and tunnel being so arranged as to permit the passage of a substantially unbroken stream of gases therethrough in a direction opposite to the direction of travel of the ware and in a path substantially parallel thereto, so as to promote a steady nonfluctuating rate of temperature change throughout the zone of graduated heat treatment.

Continuous kiln. HALVER R. STRAIGHT. U. S. 1,711,910, May 7, 1929. A continuous kiln comprising an arched wall construction to form a tunnel, a floor for dividing the space within the tunnel into kiln and basement compartment, tracks on the floor of the kiln, cars for the tracks having ware stacked thereon, the interior face of the arch being provided with longitudinal grooves to receive the longitudinal and upper corners of the stack of ware, means for adjusting the tracks vertically and transversely to adjust the corners of the stack of ware relative to the grooves.

Tunnel kilns. A. M. ROBERTSON. Brit. 306,813, April 24, 1929. In a continuous tunnel kiln of the muffle type, comprising a heating zone and main and secondary cooling zones, air heated, is supplied under pressure to chambers arranged along the sides of the heating zone and enclosing conduits through which the hot gases pass to spaces connected by pipes to an exhaust fan. The chambers are divided by vertical partitions and are formed with upper and lower openings which allow a continuous circulation of the air through the ware on the trucks and the heating chambers. At their inner ends, the conduits are connected to secondary combustion chambers which communicate through openings with main combustion chambers, these latter being fired by gas or oil burners or by solid fuel and formed with a passage in the lower walls for the supply of air for combustion. In the main cooling zone, conduits, supported by pillars, extend between air inlet spaces and chambers, the latter being connected by a transverse flue from which the heated air is withdrawn by a fan and supplied to pipes having valved branches leading to spaces below the side chambers. The excess air is withdrawn from the tunnel through pipes connected to the exhaust fan and serves to preheat the entering goods during its passage toward the inlet end of the kiln. The cooling in the zone is effected by air which is admitted to a chamber adjacent the roof and passes through pipes to side chambers having outlets.

Charging and discharging in brick kilns. O. MOLLE AND ATELIERS J. HANREZ SOC. ANON. Brit. 307,815, May 8, 1929. In a kiln for firing ceramic and other products the goods are stacked on slabs in which are taken by trucks into the kiln, the trucks being run onto traversing trucks so that the slabs with their loads can be deposited at any desired point within the kiln. The platform of the truck is capable of vertical movement so that a slab can be deposited on dwarf walls and left, while the truck is withdrawn to fetch another load. When the kiln is fully charged the slabs form a more or less continuous floor. In a modification the rails for the traversing truck are at right angles to the front of the oven, and on each side are walls and rails for the goods trucks.

Geology

Talc and soapstone. RAYMOND B. LADOO. Bur. Mines, *Bull.*, No. 213, 133 pp.—Talc is a hydrous magnesium silicate having the chemical formula $H_2Mg_3(SiO_3)_4$; it is often called steatite, soapstone, or potstone, and by trade names: talc clay, agalite, asbestine, and verdolite. The mineralogy and characteristics of talc and soapstone, the origin and geological occurrence, distribution, world production, factors influencing new talc-mining ventures, prospecting and development, quarrying and milling of slab soapstone, mining methods, milling and separation by different methods, uses and testing and representative mines and mills are discussed. R.A.H.

Talc and soapstone in 1927. B. H. STODDARD AND J. A. DORSEY. Bur. Mines, *Mineral Resources of the U.S.*, Part II, pp. 181–86 (1929).—The total quantity of talc

sold by producers in the U.S. in 1927 amounted to 192,316 short tons, valued at $2,234,-724. There were 21 producers of talc operating 21 mines in 1927. Detailed statistics on talc and soapstone and the various forms in which it is marketed are given. A list of producers is given, as well as a review of production by states together with uses and exports and imports. R.A.H.

The sulpho-aluminates of calcium. W. LERCH, F. W. ASHTON, AND R. H. BOGUE. Bur. Stand., *Jour. Research*, **2** [4], 715–31 (1929).—Two calcium sulpho-aluminates have been prepared and their compositions and optical characteristics determined. One of these having the composition $3CaO{\cdot}Al_2O_3{\cdot}3CaSO_4{\cdot}31H_2O$, is relatively stable in aqueous solutions but is decomposed by solutions of magnesium salts and of carbonates. The other, having the composition $3CaO{\cdot}Al_2O_3{\cdot}CaSO_4{\cdot}12H_2O$, is relatively unstable except in high concentration of hydroxyl ion. It is readily converted to the high sulphate form in aqueous solutions but is decomposed by magnesium salts and carbonates. In sulphate solutions the high sulphate form may be produced, but in the presence of a slight excess of magnesium salts or carbonates neither of the sulpho-aluminates can continue to exist. In these cases the less soluble magnesium hydroxide and calcium carbonate, respectively are formed. R.A.H.

Developing potash industry. ANON. *Amer. Glass Rev.*, **48** [29], 33 (1929).—The U.S. has reached only the stage of exploration and experimentation with its resources. If present efforts in this line of research are continued, this country may assume a leading place in the field of producers. E.P.R.

Phosphate rock industry of Tennessee. ANON. *Cement, Mill & Quarry*, **34** [5], 39 (1929).—Tenn. is the 2nd largest phosphate rock-producing state, ranking next to Fla., and has maintained this position since it passed S.C. in 1899. Types of rock and methods of mining and milling are described. E.P.R.

Missouri's barite industry. ANON. *Cement, Mill & Quarry*, **34** [5], 39 (1929).—In Technical Publication, No. 201, Non-Metallic Minerals, No. 6, W. M. Weigel states that in 1914, Mo. produced two-thirds of the U.S. output of barite; since then, other districts have increased their output. The geology of the Mo. deposits is described, giving the types of deposit and their origin, description of mining methods, prospecting, hand mining (including costs), and mechanical mining methods. Milling and cleaning, hand methods, combined mechanical and hand cleaning, and mechanical concentration are described in detail. Marketing, transportation, and utilization of barite conclude the paper. E.P.R.

Molten glass as earth's core. ANON. *Amer. Glass Rev.*, **48** [32], 14 (1929).—R. A. Daly, Harvard University, told the Seismological Society at Fordham Univ., that the center of the earth (about one-half of its radius) is a core under pressure of 50,000,000 pounds per square inch and under heat of more than 50,000 °C. This core is surrounded by successive shells, each relatively homogeneous, but not too sharply bounded. The outer shell forms the earth's crust and is some 30 miles deep. The commonest rock of this outer shell is granite; that of the underlying layer dark-colored basalt, and surrounding the actual core, a material not unlike the metallic iron of the meteorites. Daly's theory of a liquid glass interior is based on a study of "X-raying the earth." E.P.R.

Geological work in Burma. T. O. MORRIS. *Refrac. Jour.*, **4** [43], 227 (1929).—The paper was chiefly concerned with the search for petroleum. It was mentioned that the ores of lead, zinc, silver, copper, tin, antimony, bismuth, molybdenum, and tungsten all occur in Burma, and only await better means of communication for their more active development. The same applies also to the ultrabasic intrusions along the eastern flank of the Arakan Yoma, which some day may furnish commercial

supplies of chromite, chalcocite, asbestos, steatite, magnesite, and even gold and platinum. E.P.R.

Zirconium deposits in Brazil. ANON. *Ceram. Ind.*, **12** [5], 557 (1929).—Zirconium oxide veins occur along the Minas-Geraes-Sao Paulo border and furnish ore which is estimated to contain an average of 73% zirconium dioxide. From Rio de Janeiro to Bahia the metal occurs as sand mixed with silicates. Zircon sand, similar to fine beach sand, is found in considerable quantities in the state of Espirito Santo, near Victoria, and was produced as a by-product of the monazite sand industry. The general run of the mines in the Victoria district is said to be 90% zirconium. The state of Goyaz is also said to have a few deposits of zirconium. All of the deposits in the Sao Paulo district consist of outcroppings of zirconium, which is mined by blasting with dynamite. The whole output is surface mined or quasi-surface mined, as there is an overburden of about 2 m. of ordinary quartz sand, underneath which are layers of ilmenite, zircon, and monazite, in the proportions of 33 : 25 : 18, respectively. The product is therefore easily mined. Electromagnetic separators are used to extract the three elements mentioned above in the order named. F.P.H.

Tin deposits of Mexico. FREDERICK MACCOY. *Min. and Met.*, **10** [269], 246–47 (1929).—Though not of present importance, the tin deposits of Mexico are sufficiently widespread to be of value in the future. F.P.H.

Mineral exploration in Newfoundland from 1917 to 1927. A. K. SNELGROVE. *Trans. Can. Inst. Min. and Met.*, **30,** 302–26 (1927). F.P.H.

Manganese production in 1928. ANON. *Chem. and Ind.*, **48,** 376 (1929).—Over 70% of the world-output of Mn is used by four countries. France used 690,000 T., the U.S. 427,708, Germany 367,270, and England 205,965 T. The U.S. is furnished by Russia and Brazil, and the other consumers by British India. A new deposit on the Gold Coast which is under U.S. control is said to have a capacity of 600,000 T. annually. Other deposits are in Cuba. H.H.S.

Potash industry in Germany. ANON. *Chem. and Ind.*, **48,** 377 (1929).—During 1928 potash sold in Germany totalled 862,000 T., compared with 780,000 T. in 1927. H.H.S.

Volcanic ash exploitation in Saskatchewan. ANON. *Chem. News*, **138,** 281–82 (1929).—The Van Kel Co. is installing a plant at Swift Current, Sask., to utilize the volcanic dust or pumicite as an abrasive, or filler in soaps, or purifier in cleansers or of lard and tallow, or for kalsomine, etc. H.H.S.

Monoclinal soda feldspar. TOM BARTH. *Z. Krist.*, **69** [5–6], 476–81 (1929).—A monoclinal albite consisting of submicroscopic triclinal twin flakes has been found in northern Norway. T.W.G.

Influence of thermal stratification on the formation of marl in lakes. E. M. KINDLE. *Jour. Geol.*, **37,** 150 (1929).—The upper layer of warm water is about five times as thick in large deep lakes as in small lakes while the bottom temperatures may be the same. Lakes at high altitudes have little or no thermal stratification. A thin zone of warm water nearly saturated with calcium carbonate is necessary to the formation of marl, hence no deposition of marl is found in the Great Lakes or in mountain lakes but only in small shallow lakes at low altitudes. C.R.A.

BOOK

Nomenclature of Petrology. ARTHUR HOLMES. Thomas Murphy and Co., London, 1928, 284 pp., $1.80. Reviewed in *Min. and Met.*, **10** [269], 266 (1929).—A reliable dictionary of rock names, including the majority of those found in geologic literature. The definitions are accurate, the introducer of each term is given, and there are numerous references to the literature. Glossaries of French and German terms and of Greek and Latin words and prefixes are given in appendices. The new edition is a re-issue of the first, with corrections, at a greatly reduced price. F.P.H.

Chemistry and Physics

Determination of air in plastic mixes. VANCE CARTWRIGHT. *Jour. Amer. Ceram. Soc.*, **12** [6], 395–98 (1929).—A laboratory procedure for the determination of air in wet clay mixes.

Importance of research on quality of product. H. J. LUCAS. *Bull. Amer. Ceram. Soc.*, **8** [5], 104–106 (1929).—Quality of product is the best asset of modern industry. For this reason, research is becoming more and more important. Some examples of how research is being carried on and with what results are cited. E.J.V.

Expansions of mercury and vitreous silica. F. H. HARLOW. *Phil. Mag. and Jour. Sci.*, No. 44, 674–85 (1929).—In the precision thermometer it is essential to know to a high degree of accuracy the thermal expansion of mercury over as wide a temperature range as is possible. In the present paper the most probable values of the thermal expansion of both vitreous silica and mercury are considered over a range of temperatures from 0 to 300°C and in each case the results are expressed in the form of suitable equations. In addition tables are constructed from which the volume of 1 cc. of mercury may be readily obtained at other temperatures through the range 0 to 300°C. J.T.L.

Rigidity in weak clay suspensions. R. K. SCHOFIELD AND B. A. KEEN. *Nature* **123,** 492 (1929).—In purifying quantities of the clay fraction or smallest sized particles in soil it was found that when the material was flocculated with dilute HCl, it settled as an entire surface, retaining any marks or imperfections in the surface as if it were a rigid body. The clear water ascended from the bottom of the vessel in chimneys of clear liquid. C.R.A.

Determination of iron in silicates. A. E. J. VICKERS. *Trans. Ceram. Soc.* [Eng.], **27** [3], 156–60 (1927–28).—Methods are described for the determination of both ferrous and ferric oxides when present in silicates. Special directions are included for the use of the Reinhardt method of titrating iron. The method given here has been found to give good results in practice, is at least as accurate as other methods and has the merit of great simplicity. R.F.S.

Properties of fullers' earth and acid-treated earths as oil-refining adsorbents. C. W. DAVIS AND L. R. MESSER. *Min. and Met.*, **10** [269], 252 (1929).—Seventeen earths are the basis of this study. These tests show that an earth may require a certain treatment to make it the most efficient adsorbent for one oil, but another treatment is better when used on another oil. Although most fullers' earths may be heated to 650 to 700°C without their efficiency being destroyed, a high magnesia (20%) earth lost much of its bleaching power at 450° and more at 600°, and an acid-treatment earth became inefficient at 600°. At 900° the bleaching power of all of the adsorbents tested was destroyed. Swelling in water seems to be peculiar to earths that became good adsorbents by acid treatment; but not all earths that swell make good oil-bleachers on treatment with acid. F.P.H.

Researches on the theory of fine grinding. IX. Statistical diameter and volume of irregularly-shaped particles of crushed sand. GEOFFREY MARTIN. *Trans. Ceram. Soc.* [Eng.], **27** [4], 247–58 (1927–28).—In the case of irregularly-shaped particles of sand, if d be their statistical diameter and V be the corresponding statistical volume, then V/d^3 = constant B the volume constant of the powder. This volume constant B is the same for large and small-sized particles. This is an experimental fact of considerable importance. Men in works have often asserted that the very finely-ground particles differ in shape from the more coarsely ground particles. All the experimental evidence given definitely refutes this view. **X. Statistical diameter of crushed sand particles and their statistical surface.** *Ibid.*, pp. 259–84.—The experimental fact is brought out that if S be the statistical surface of the particles of statistical diameter

d, then: S/d^2 = constant A, no matter whether the particles are of large or small size. A, is called the "surface constant." It is shown that for sand particles ground in a tube mill and of statistical diameters ranging from 0.00333 cm. to 0.01089 cm. diameter this surface constant is about 2.1. In other words, if the statistical diameter of a particle be d cms., the statistical surface of this particle will be 2.1 d^2 cms. The surface constant of particles of crushed quartz is sensibly equal both of large size particles and small size particles, ranging from 2.0 to 2.49. The average shape of the particles remains the same both in the coarse grades and in the fine grades. **XI. Calculations on diameters, surfaces, and weights of homogeneous grades of crushed quartz sand.** *Ibid.*, pp. 285–89. By means of the surface and volume constants, the surface, volume, and weight appertaining to any homogeneous grade of crushed quartz sand can be calculated. The chief numerical data relating to 20 homogeneous grades of quartz particles ranging in size from 31,000,000 to the gram to 1240 to the gram are given. Methods of calculating the volumes, surfaces, and weights of different-sized powders are presented. R.F.S.

Crystalline break-up of kaolin. J. F. HYSLOP. *Trans. Ceram. Soc.* [Eng.], **27** [4], 299–302 (1927–28).—X-ray examination shows (*a*) the breakdown of the kaolin lattice at 550°C with the formation of a crystalline phase, α; (*b*) the 870°C critical point is associated with the breakdown of a silicate lattice (α) and with the appearance of Al_2O_3 and sillimanite; (3) the Al_2O_3, without showing evidence of the formation of Al_2O_3, persists beyond the finish of the 870°C critical point, but over 1060°C it decreases and eventually disappears. This indicates that the 870°C point is not associated with an alumina change, and also shows the existence of sillimanite under 1060°C. Above 1060°C, there is reaction with the formation of mullite. R.F.S.

Effect of water vapor and sulphur dioxide on firing clays. J. KONARZEWSKI. *Trans. Ceram. Soc.* [Eng.], **28** [1], 18–25 (1929).—The effect of water and sulphur dioxide on the process of dehydration of china clay was investigated. Up to 550°, water vapor retards dehydration. Above this temperature there is practically no difference between dehydration of china clay in a stream of dry air and in a stream of water vapor. Sulphur dioxide does not influence the dehydration of china clay. Clays fired in the presence of sulphur dioxide take up small amounts of sulphur forming sulphates of calcium, magnesium, aluminum, and iron. The combined sulphur can be completely removed by firing in an oxidizing atmosphere. R.F.S.

The melting point of potassium chromate. DAVID F. SMITH AND F. A. HARTGEN. Bur. Mines, *Rept. of Invest.*, Serial No. 2917 (March 1929).—A careful re-determination of the melting point of pure potassium chromate gives 968.3°C with a probable accuracy of ±0.5%. It would therefore appear that the melting point chosen by the International Critical Tables is about 7° too high and that noted by the A.S.T.M. is about 28°C too low. R.A.H.

Decomposition of ceramic silicates for chemical analysis. ANON. Bur. Stand., *Tech. News Bull.*, No. 144, p. 33 (April, 1929).—The method ordinarily used for decomposing silicates preparatory to their chemical analysis consists of fusing them with several grams of sodium carbonate. A method comparatively unknown for this type of work consists essentially of intimately grinding together a weighed amount of the silicate with not more than an equal weight of sodium carbonate, transferring the mixture to a platinum crucible and heating it for about an hour over a Tirrill or Meker burner. Ten ml. of water are added to the cooled mix., the crucible is placed on steam bath; shortly thereafter 10 ml. of hydrochloric are added, and the mixture is evaporated to dryness. Ten ml. of the same acid are added and the crucible filled with water; after digesting, the silica is filtered and the analysis is completed in the usual manner. An advantage in this procedure is that the decomposition of the silicate and the dehydration of the silica

can be carried out in the crucible in which the sintering was done. The greatest advantage lies in the fact that the amount of sodium oxide to be washed out of the various precipitates may in some cases be reduced from 4.5 to 0.2 g. R.A.H.

Coefficient of expansion of English china clays. ANON. Bur. Stand., *Tech. News Bull.*, No. 144, pp. 33–34 (April, 1929).—Determinations of the coefficient of linear expansion of 17 English china clays which had been fired to seven different temperatures were made by the Fizeau-Pulfrich method. The thermal-expansion curves obtained are practically in character over the range investigated, from room temperature to 600° C. This is a peculiarity of the curves for clays fired to cones 3, 5, and 7. In each case the slope of the curve decreased between the range 120 to 280°C. A second test of the same specimen showed this "kink" to be eliminated. It is believed that this "kink" was caused by water present in the specimen. From an examination of the results obtained it would appear that the average tendency was for a gradual increase in the value of the mean coefficient of linear expansion from cone 3 to cone 11, followed by a gradual decrease for clays fired at the higher temperatures. R.A.H.

Analysis of fluorspar. G. E. F. LUNDELL AND J. I. HOFFMAN. Bur. Stand., *Jour. Research*, **2** [4], 671–83 (1929).—In connection with the standardization of the Bureau of Standards standard sample of fluorspar No. 79, old methods of analysis were tested and modified, and new methods developed. Procedures that have been found desirable for the determination of carbonates, silica, calcium fluoride, sulphur, barium, lead, and zinc are given. R.A.H.

Determination of molecular weights in the vapor state from vapor pressure and evaporation data. EDWARD W. WASHBURN. Bur. Stand., *Jour. Research*, **2** [4], 703–13 (1929).—If one determines at the same temperature the vapor pressure of a substance and the amount of it required to saturate, by aspiration, a measured volume of an indifferent gas, the molecular weight of the substance in the gaseous state is calculable. By employing a reference substance of known molecular weight the measurement of the volume of aspirated gas is unnecessary and the quantities measured have small temperature coefficients. A precision discussion of the method is given. It should be capable of a high degree of accuracy in many cases and is applicable at much lower temperatures than are the methods commonly employed. R.A.H.

Properties and theories of gels. EMIL HATSCHEK. *Chem. and Ind.*, **48**, 389–99 (1929).—The properties of various types of gels, the principal theories of their structure, and a summary of a number of original investigations which have a bearing on these theories are given. Freundlich classified gels into (1) elastic gels, like gelatin, (2) inelastic (Ger. starr) gels, like silicic acid, (3) unstable, formed transiently in cooling certain solutions which later crystallize, *e.g.*, manganous arsenate, and (4) formed when the dispersion medium of certain sols is replaced very gradually by a liquid miscible but not solvent for the disperse phase. Among theories of structure, that of Poole is chosen as being the only one which hitherto has led to quantitative results. Poole presupposes a spongelike structure consisting of elastic fibrils without free ends, orientated at random and filled with viscous liquid. H.H.S.

Cobalt detection by potassium cyanate. B. J. F. DORRINGTON AND A. M. WARD. *Chem. News*, **138**, 254–55 (1929).—KCNO reacts with Co to form a blue complex. The test is sensitive in alcoholic solution to $^1/_{100}$th of a mol. Cu interferes, and Fe forms a precipitate with the reagent. H.H.S.

Speedy control during manufacture. K. PFEFFERKORN. *Sprechsaal*, **62** [1], 1–4 (1929).—P. describes quick methods by simple apparatus to check on the chemical composition of ceramic raw materials such as loss on ignition, determination of SiO_2, Al_2O_3, Fe_2O_3, and alkalis. T.W.G.

Determination of soluble solids in clayware. O. KALLAUNER. *Sprechsaal*, **62** [2], 19–21; [3], 35–37; [4], 53–56 (1929); for abstract see *Ceram. Abs.*, **7** [2], 77 (1928). T.W.G.

Contribution to the question of the citric acid solubility and hardness of basic slag. H. WEISS. *Arch. Eisenhüttenw.* **2,** 81–85 (1928).—The dependence of the citric-acid solubility on the silica degree is shown diagrammatically. Methods for raising the silica degree, the relation of the silicon content to the phosphorus content in the pig iron, and the action of a sand addition in the converter were investigated. By means of the analyses of about 200 slags with approximately similar silica degrees, it is shown that each 1% increase in the amount of fine powder increases the citric acid solubility by about 0.33%; the economic limit to the degree of fine grinding was investigated. High temperatures of the charge and a low proportion of lime raise the citric-acid solubility, whereas rapid cooling decreases it and hardens the slag. Hard slag results especially from high-silicon pig iron, and besides higher silica and manganese contents, it always contains much ferrous oxide with little ferric oxide. The unfavorable effect of hardness on the solubility is predominantly of a mechanical nature. (*J.I.S.I.*)

Pyrometers for surface temperature measurements. ANON. *Foundry Trade Jour.*, **39,** 79–80 (1928).—Particulars are given of types of electro-thermic pyrometers suitable for measuring the temperatures of hot metal surfaces. (*J.I.S.I.*)

Measurement of surface temperature. D. F. OTHMER AND H. B. COATS. *Ind. Eng. Chem.*, **20,** 124–26 (1928).—Methods for attaching thermocouples to heating surfaces by mechanical means may give satisfactory results, but may also give very erratic results. If the junction is formed by plating a layer of the second metal on the surface whose temperature is to be studied, and if the leads are attached before plating so that they are embedded in the plate, uniform results are obtained. Directions are given for making nickel-copper junctions on tubes. (*J.I.S.I.*)

Practical pyrometry. G. B. BROOK AND H. J. SIMCOX. (Paper read before the Institute of Metals, Oct., 1928.)—Difficulties, such as stray current and magnetic fields of great intensity, which are peculiar to industries where large currents are used are outlined. An instrument has been designed which eliminates these and is accurate even when placed in the field surrounding a conductor carrying as much as 20,000 amp. (*J.I.S.I.*)

Thermo-electric measurement of temperatures above 1500°C. H. L. WATSON AND H. ABRAMS. (Paper read before the American Electrochemical Society, Sept., 1928.)—After a brief discussion of the standard methods of temperature measurement from 1000 to 2000°C, an account is given of a tungsten-graphite thermocouple. This couple has been used, with suitable protection, to over 1700°C in oxidizing atmospheres. Repeated runs to 1850°C have been made in the vacuum furnace, as well as short runs to about 2400°C at atmospheric pressure in reducing atmospheres. (*J.I.S.I.*)

Heat content and the specific heat of some slags at high temperatures. S. UMINO. *Sci. Repts. Tôhoku Imp. Univ.*, **17,** 985–96 (1928).—U. has obtained the heat content and the mean specific heat for a blast-furnace slag and a basic open-hearth slag at temperatures ranging from 100 to 1500°C by the calorimetric method of mixtures. The slags were found to possess no definite melting point, but to soften and melt gradually in a certain range of temperatures. (*J.I.S.I.*)

BOOKS

Chemistry of Colloids. PAUL BARY. Preface by M. E. Fleurent. 132 pp., 29 illustrations. Published by Donald, Paris (6e), France. Price: in France 16 fr. 10, abroad 20 fr. This book is a short treatise on the subject of colloidal chemistry It consists of a series of lectures. The first part consists of a theoretical treatise of the subject,

the second part is devoted to the numerous technical applications. Reviewed in *Glass Ind.*, **10** [5], 119 (1929). E.J.V.

Introduction to theoretical physics. LEIGH PAGE. D. Van Nostrand Co., New York. 585 pp. Price $6.50.—The book introduces the reader to vector analysis in the first section and uses Gibbs' vector notation in later discussions. There are five main divisions to the work: (1) dynamics; (2) hydrodynamics; (3) thermodynamics; (4) electrodynamics; (5) optics and spectroscopy. A good working knowledge of differential equations is assumed. E.J.V.

Laboratory Investigation of Ores. ANON. Edited by E. E. Fairbanks. 262 pp. Illus. McGraw-Hill Book Co., New York, 1929. Price $3.50. Written by twelve specialists, the chapters deal with polished sections, microscopes, X-ray analysis, photomicrography, dielectric methods, grain significance, ore-mineral sequence, replacement in minerals, textural relationships, geologic thermometry, enrichment of ores, zonal distribution, and ore-dressing microscopy. H.H.S.

Methods in Non-Ferrous Metallurgical Analysis. R. KEFFER. 335 pp. Illus. McGraw-Hill Book Co., Inc., New York, 1929. Price $4.00 postpaid. H.H.S.

PATENT

Converting silicates containing lithia with neutral alkali metal salts. CONWAY VON GIRSEWALD. U. S. 1,710,556, April 23, 1929. A process which comprises heating a lithia-containing silicate with a neutral alkali metal salt at a temperature between 600 and 950°C.

Aluminium chloride. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 305,578, April 4, 1929. The production of anhydrous aluminium chloride from raw materials containing both alumina and silica in the presence of a reducing agent such as carbon or carbon monoxide is carried out with chlorine charged with silicon tetrachloride vapor in such amount that no simultaneous formation of silicon tetrachloride from the silica present can take place. Equal proportions of chlorine and silicon tetrachloride may, for instance, be used, the chlorine being passed through a bath of the liquid tetrachloride at a chosen temperature, and the tetrachloride may be condensed for re-use after separation of aluminium chloride. Examples relate to the chlorination at 750°C of a carbonized mixture of clay and brown coal, (*a*) with approximately equal amounts of chlorine and the tetrachloride, the whole of the latter being recovered, and (*b*) with excess of the tetrachloride with respect to the chlorine, in which case a part of the former is decomposed into silica and assists the chlorination of the alumina. It is stated that excess of chlorine with respect to the tetrachloride may also be used, in which case some silicon tetrachloride is formed from the silica present; and a further example relates to chlorination by chlorine only, illustrating the simultaneous formation of silicon tetrachloride and aluminium chloride.

Chromic hydroxide; formates. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 305,588, April 4, 1929. Chromium green and alkali or alkaline earth formates are simultaneously formed by reduction in solution with carbon monoxide or gases containing it of an alkali or alkaline earth chromate. Preferably temperatures of 150 to 350°C are used under increased pressure.

Alumina; sodium carbonate; hydrochloric acid. N. J. GAREAU. Brit. 305,599, April 10, 1929. Calcined clay briquets are supplied to a tower up which passes a stream of hot gases accompanied by sulphur oxides obtained as products of decomposition from the hearth of the furnace and nitrogen oxides, and down which water is sprayed. Sulphuric acid is formed and reacts with the clay to form aluminium sulphate. The silica becomes dehydrated. The briquets are removed from the base of the tower and are lixiviated with water containing sulphuric acid to form a solution of aluminium sulphate which is dried and calcined on the hearth of the furnace to yield a product of the formula

$Al_2O_3 \cdot SO_3$. The porous mass is ground with sodium chloride and small coal and formed into briquets which are heated to about 300°C and treated with steam to yield hydrochloric acid and are afterward heated to a red heat in a balling furnace, when sodium sulphate is reduced to sulphide with evolution of carbon dioxide which is led into the furnace. The briquets are treated at a high temperature with steam yielding sodium aluminate and sulphuretted hydrogen which on burning forms sulphur dioxide which is passed into the furnace. The fused mass of sodium aluminate is lixiviated, when magnesium separates as insoluble magnesium aluminate. The solution of sodium aluminate is treated with the scrubbed gases issuing from the top of the tower forming a precipitate of alumina and a solution of sodium carbonate.

Aluminium compounds. U. B. VOISIN. Brit. 306,095, April 10, 1929. A mixture of finely-pulverized bauxite or other aluminiferous material and pulverized fluorspar is heated with concentrated sulphuric acid. Silica present is converted to silicon fluoride which is evolved and in the presence of water is collected as hydrofluosilicic acid. The mixed sulphates of aluminium and iron obtained are dissolved in water, the iron oxidized if necessary, and the solution treated with calcium chloride to obtain a solution of chlorides from which a mixture of aluminium and ferric hydrates is precipitated by lime, with formation of calcium chloride which may be re-used. The mixed hydrates may be treated with soda lye to form a solution of sodium aluminate from which, after separation of the ferric hydrate, alumina may be precipitated by carbon dioxide. The solution of sodium carbonate also obtained may be converted to caustic soda for re-use.

Aluminium compounds. W. BACHMANN. Brit. 307,345, May 1, 1929. Aluminium fluoride or double alkali-aluminium fluorides are obtained by treatment of an aluminium salt such as the chloride, nitrate, or sulphate with a metal fluoride such as an alkali metal or ammonium fluoride in solution or suspension, if desired at elevated temperatures or under pressure; or a mixture of the solid salts may be heated together. In carrying out the process an aluminiferous substance such as clay may be treated for instance with nitric acid to obtain aluminium nitrate, the latter be reacted with sodium or potassium fluoride to obtain aluminium fluoride and an alkali nitrate, the nitrate be reacted with hydrofluosilicic acid to regenerate nitric acid and obtain sodium fluosilicate which is then decomposed by heat to obtain sodium fluoride for re-use, and silicon fluoride which may be converted into hydrofluosilicic acid. Alternatively the sodium nitrate may be treated with calcium fluoride and silicon fluoride to obtain calcium nitrate, and sodium fluosilicate which may be decomposed by heat into sodium fluoride for re-use, and silicon fluoride which may be converted into sodium fluosilicate. Aluminates may be obtained from the aluminium fluoride by the action of alkalis or alkaline earths or their carbonates and alumina be precipitated from the solutions obtained in known ways; or the fluoride may be decomposed by heat in the presence of water or other substance adapted to bind the fluorine. For instance, the decomposition may be effected in the presence of saturated or superheated steam, if desired under reduced pressure, to obtain alumina and hydrofluoric acid, or in the presence also of silica with formation of silicon fluoride, or by means of hydroxides. The fluorine compounds so obtained may be re-used, after conversion if necessary, into appropriate fluorides.

Metallic oxides; silica. J. BLUMENFELD. Brit. 307,881, May 8, 1929. The formation of oxides of titanium, zirconium, and similar metals from the corresponding halides is conducted with the latter in dispersion in an inert medium extractable from the oxides by leaching. The halides may be distributed in soluble solid salts such as alkali, alkaline earth, or rare earth chlorides or sulphates and decomposition be effected by steam about 300 to 400°C, the decomposed mass being further heated to 800 to 1000°C before leaching out the alkali, etc., salt. A finely-divided oxide is finally obtained. The process may be applied to the production of silica.

General

Statistical aids in locating pottery troubles. W. KEITH MCAFEE. *Jour. Amer. Ceram. Soc.*, **12** [6], 399–405 (1929).—The importance of performance records in pottery production and the advantages of arranging performance data in proper time relationship are pointed out. An outline of pottery record system is appended.

Comment on the International Ceramic Exhibition. EDMUND DE F. CURTIS. *Bull. Amer. Ceram. Soc.*, **8** [5], 95–99 (1929).—The purpose of this exhibition is to afford an opportunity to compare American productions with those of Europe. It is regretted that some of the work of other American ceramic artists was not included also. A ceramic product must have real distinction in order to be worthy of a place in ceramic history. A collective comparison of American and foreign ware is made. Some of the individual exhibits of especial interest are listed. Suggestions for future exhibits are offered. E.J.V.

Hot alkaline solubility of fire-polished sodium–lime–silica glasses as function of the chemical composition. W. MÖLLER AND E. ZSCHIMMER. *Sprechsaal*, **62** [3], 38–39; [4], 57–60; [5], 79–82; [6], 94–95; [7], 115–16; [8], 133–34; [9], 150–54 (1929).—Fifteen melts of the sodium–lime–silica system were made in a platinum crucible and analyzed. The melts were chemically pure with the exception of aluminum oxide, iron oxide, and titanic acid (0.12 to 0.18%) and a small amount of potassium (0.1%). Immediately after melting and partial cooling cylindrical threads of about 1 mm. diameter were pulled several meters long. They were divided into sections of 12 cm. length and the ends rounded off by a burner. In this manner it is possible to obtain easily fire-polished surfaces, the size of which can be measured accurately up to 0.6%. These sectional threads or sticks were gathered in bundles of from 30 to 40 each and after thorough cleaning, were placed in water at 98°C and maintained within ±0.1°C for 3 hrs. The dissolved sodium was determined by titration using red methyl as an indicator. The alkaline solubility was measured within ±3%. The curves were regular. They formed the basis of the design of diagrams in which the lines of equal alkalinity for the triple system silica–lime–soda were constructed. The lines of equal alkalinity were called isokales. From the isokale diagram a table was made which can be used to calculate the hot alkaline solubility of the fire polished surface for any sodium-lime content. With this it is possible to properly classify sodium–lime–silica glasses. To correct the influence of a small amount of aluminum oxide, the effect of 1% aluminum oxide in pure sodium-lime-silica glasses was determined. T.W.G.

Utilization of waste heat for steam raising. GEOFFREY MARTIN. *Trans. Ceram. Soc.* [Eng.], **27** [4], 222–41 (1927–28).—Hot gases could be economically utilized to a far greater extent than ever before. Waste heat boilers have been erected of an efficiency far exceeding anything generally thought possible. It is possible to use them economically with exit gases issuing at temperatures as low as 600°F, and with some types of furnaces they will yield more than enough power to run the whole works. Two main systems are in use today, namely (1) the water tube system and (2) the fire tube system. A typical plant of each system is described. R.F.S.

Utilization of waste heat in the steel industry. G. R. MCDERMOTH. *Fuels and Fur.*, **6** [11], 1579 (1928).—The abstract of a paper presented at the joint meeting of the Engineers Society of Western Pennsylvania and the Amer. Soc. of Mech. Eng., Pittsburgh, Pa., Oct. 22, 1928. A.E.R.W.

Dew points of waste gases and their importance for waste heat feed-water heaters. A. SAUERMANN. *Glückauf*, **64**, 1211–15 (1928).—If the temperature of the incoming water in waste gas feed-water heaters lies below the dew point of the waste gases, trouble will arise, as the deposition of the water vapor will cause rusting to occur, thus damaging the heater tubes. In order to determine the temperature at which the feed-water should

enter the heater, an investigation of the principal fuels with regard to their composition, their water content, and the humidity and degree of excess of the air for combustion, was undertaken. An example of the method of calculation is given, and the results are discussed. (*J.I.S.I.*)

Factors which influence the choice of waste-heat boilers. J. B. CRANE. *Iron and Steel Eng.*, **5,** 407–12 (1928).—If the pressures, weight, and character of gases are suitable, the return tubular boiler will give the maximum results for the least outlay. If the conditions are not suitable for return tubular boilers, a vertical boiler is the most suitable. The single pass horizontal boiler is suitable for special conditions, and may be used in some cases in place of vertical boilers. (*J.I.S.I.*)

Balancing heat and power in industrial plants. R. V. KLEINSCHMIDT. (Paper read before the A.S.M.E., Dec. 1928.)—The purpose of this paper is to indicate the importance of various factors in increasing the amount of by-product power that can be generated in industrial plants using process heat. It is shown that there are opportunities for economies in increased boiler pressures, high superheats, and particularly by reducing the back pressure on turbines and engines to the lowest possible point. Utilization of waste heat from heating furnace gases offers an opportunity for additional power generation in mixed-pressure turbines or in low-pressure condensing turbines. It is shown that hot air can be most economically used by returning it to the boiler furnace, and by heating air for process work with exhaust steam. Two curves are presented which give the results of a detailed analysis of the problem of water heating, one showing the advantages of two-stage water heating as compared with heating by exhaust steam only, and the other giving the best condenser vacuum for various initial and final temperatures of water in a two-stage process. Attention is called to the importance of an adequate study both of the heat and power requirements of the process, and of possible alterations of process as a basis for the improvement of the heat-power balance. (*J.I.S.I.*)

Waste-heat recovery. F. J. BAILEY, W. GREGSON, AND J. W. REBER. Paper read before the Fuel Conference of the World Power Conference, Sept. 1928; *Gas Jour.*, **184,** 130–31 (1928). (*J.I.S.I.*)

Power-house measurements. ANON. *World Power*, **9,** 290–92, 355–56; **10,** 50–52, 164–66, 271–74 (1928).—A series of articles dealing with the use of measuring, indicating, and recording instruments in power-houses. Various types of combustion control apparatus also described. (*J.I.S.I.*)

Pulverized fuel equipment. ANON. *Cement, Mill & Quarry*, **34** [5], 64 (1929).—A new 52-page catalog covers briefly the development and application of the unit system for firing pulverized fuel. Illustrations are given of plants and sectional elevations through the steam generating units. E.P.R.

Pulverized fuel in metallurgical furnaces. G. E. K. BLYTHE. *Fuels and Fur.*, **6** [12], 1661–64 (1928).—(The abstract of a paper presented at the Second International Conference on Bituminous Coal, Pittsburgh, Pa., Nov. 19–24, 1928.) B. presents a theoretical consideration of the burning of pulverized coal and the application of pulverized fuel to various forms of metallurgical heating. The equipment for pulverized fuel installations such as pulverizers, driers, and transporting equipment are described. A.E.R.W.

Modern stoker. J. W. ARMOUR. *Fuels and Fur.*, **6** [12], 1657–58 (1928).—(Abstract of a paper presented at the Second International Conference on Bituminous Coal, Pittsburgh, Pa., Nov. 19–24, 1928.) Three factors in the design and application of stokers which have contributed to the advancement of the science of burning coal on a fixed grate are (1) use of preheated air, (2) proper application or admission of air to the fuel bed, and (3) substitution or supplementing of refractory-lined furnaces with

water-cooled or air-cooled walls. The following factors must be considered in selecting equipment for a new plant: first cost, operating charges, maintenance costs, efficiency, type of coals available, and the nature of the load at the plant. A.E.R.W.

A combined boiler and producer plant. C. LONGENECKER. *Blast Fur. Steel Plant*, **16**, 642–45 (1928).—An illustrated description is given of the boiler and producer plant of the Sharon Steel Hoop Co. There are two 500 H.P. Stirling boilers and four 10 ft. diameter Morgan producers all housed under one roof, which has greatly reduced the labor required for supervision and coal handling. The boilers are fired with producer-gas. (*J.I.S.I.*)

C-E multiple retort underfeed stoker. ANON. *Cement, Mill & Quarry*, **34** [5], 64 (1929).—The Combustion Engineering Corp. announces its C-E multiple retort stoker. The design has changed materially. E.P.R.

Stoker operation. T. MAYNZ. *Fuels and Fur.*, **6** [10], 1408 (1928).—(The abstract of a paper presented at the Second National Fuels Meeting, Cleveland, Ohio, Sept. 17 to 20, 1928.) Stokers are divided into six classes, (1) hand or semi-automatic, (2) overfeed, inclined, or V-type, (3) natural-draft chain or traveling grate, (4) industrial underfeed, single, double, or lateral retort, (5) forced-draft chain or traveling grate, and (6) multiple-retort underfeed. The six types are divided into two types of installations, (*a*) the lightly loaded, short-hour, or low load factor industrial plant and, (*b*) the heavy-duty continuously operated, central station or industrial. Stokers of types 1 and 2 belong in plant *a* class, while stokers 5 and 6 are adapted to plants in class *b* exclusively. Stokers of types 3 and 4 may be used in either class of plant depending on their size. The advantages of each class of stoker are related to specific plant conditions. A.E.R.W.

Air infiltration in boiler and furnace practice. H. EDWARDS. *Fuel Econ.*, **3**, 685–87 (1928).—The causes and prevention of air infiltration, and its influence on efficiency are discussed. (*J.I.S.I.*)

Air-conditioning in deep mines. R. W. WATERFILL. *Min. and Met.*, **10** [269], 251 (1929).—The present method of cooling mines is by circulating large quantities of air through the workings. A practical means is refrigeration. The plant may be underground or on the surface, but if the plant gives off noxious odors it should be on the surface. A centrifugal-refrigeration system, employing "Carrene" (CH_2Cl_2) as a refrigerant and de-humidifying apparatus, in the mine, is described by the author. The refrigerant is noncombustible and not noxious. F.P.H.

Consuming and eliminating smoke from boilers. W. SCOTT. *Trans. Ceram. Soc.* [Eng.], **27** [4], 322–26 (1927–28).—When a stoker refuels his fires, a heavy smoke is given off. As the stoker replenishes his fires he admits the amount of steam and air required; and after the period of distillation of gases has passed he closes his steam and air controls. While the fire is incandescent the apparatus is creating a fresh supply of heated air, a reserve supply for the time of refueling of the furnaces. With the old economizers, combustion took place in the fire box only. With this one there is not only combustion in the fire box but also in the bottom flue and under and about the boiler itself. All the unburnt gases which have been wasted are now being used and the maximum value of the fuel is obtained by reason of the secondary combustion taking place. R.F.S.

Humidified air on rock-dusting material. ANON. *Cement, Mill & Quarry*, **34** [5], 22 (1929).—Efficacy of ground limestone for preventing the explosion of coal dust or for arresting a coal dust explosion in a mine depends to a considerable degree upon the ability of the dust to form a finely divided suspension or cloud in air when raised from the entry surfaces or released from rock-dust barriers in the path of the explosion. When the rock-dusting material becomes damp or wet its efficacy is reduced. In the Pittsburgh Ex-

periment Station, U. S. Bur. Mines, 21 samples of limestone and mixtures of equal parts of these materials with Pittsburgh coal dust were exposed continuously for 4 months to air practically saturated with water vapor at room temperatures (average condition 97 to 100% relative humidity at 75°F). Moisture determinations made at the beginning and end of 1, 2, and 4 months' exposure showed that nearly all of the samples had gained slightly in moisture content at the end of the first 30 days, and had practically reached equilibrium in that time. None showed a tendency to become damp or to cake. Wetting and caking result from deposition of moisture due to temperature changes which cause condensation; or by water dripping from roofs. E.P.R.

Physical properties of fuels. H. H. LEWIS. *Eng. Boil. House Rev.*, **42**, 204–209 (1928).—A preliminary article of a series dealing with the economical operation of steam boiler plants. (*J.I.S.I.*)

New chromium steel products may be competitors to ceramic ware. ANON. *Ceram. Ind.*, **12** [5], 530 (1929).—A number of steel articles made from a new chromium nickel steel developed some years ago by Krupp interests, now on display at the Ludlum Steel Co., Watervliet, N. Y., may be regarded as competitors to ceramic products, especially the glassware, enamelware, and potteryware industries. This new alloy is finding a wide field of application in high-grade cutlery for kitchen and tableware because of its stainless quality and its ability to take a mirrorlike polish. F.P.H.

Handling explosives. ANON. *Cement, Mill & Quarry*, **34** [5], 22 (1929).—Railroads of the U.S. and Canada during 1928 handled more than a half billion pounds of black powder, dynamite, and other high explosives without the loss of life or personal injury. Money losses amounted to $77. E.P.R.

Improvement in drilling efficiency with jack-hammers. P. M. NEWHALL AND L. PRYCE. *Trans. Can. Inst. Min. and Met.*, **30**, 390–421 (1927).—The primary object of the investigations was standardization of rock drills and their equipment. The earlier experiments showed high relative importance of condition of steel, available time, etc., and that there was room for improvement in other things besides the rock drills themselves; and so the scope of the investigations was extended. Increase of footage drilled per shift with a 50-lb. wet jack-hammer of 16 ft. in 1923 to 63 ft. in 1929 or nearly 300% has been effected with no large change in method or machine. F.P.H.

Underground clay mining. C. N. SCHUETTE. *Brick Clay Rec.*, **74** [10], 671–73 (1929).—A description of the methods used for mining high-grade fire clays formed from volcanic rocks, in Amador County, Calif. The clay as mined is 8 to 10 ft. thick, of which the upper 1 to 2 ft. are light gray in color from the contained organic matter and exhibit a greater unctuousness than the lower white clay. E.J.V.

Ceramic investigations at the Bureau of Standards. ANON. *Ceram. Age*, **12** [5], 169–76 (1928).—The following ceramic investigations in progress at the Bureau of Standards are described and the findings to date reported briefly: (1) *Whiteware:* feldspar and its effect in pottery bodies; machine for testing resistance of chinaware to impact; tests of international standard sample of Zettlitz kaolin; properties of English china clays; glaze fit. (2) *Refractories:* sagger problems; fundamental properties of fire clay and fireclay products; thermal expansion of fire clays and special refractories; behavior of clay minerals on heating; service of refractory blocks in small experimental glass tank; boiler furnace refractories. (3) *Glass:* glass production; relation between composition and physical properties of glass; viscosity of glass; large glass reflector for astronomical use. (4) *Enamels:* light colored ground coats for sheet iron; cast iron for enameling purposes; adhesiveness of vitreous enamels to metal. (5) *Heavy clay products:* characteristic properties of clays; machines for extruding clay columns; architectural terra cotta; terra cotta faced masonry walls; kiln scum, dry-house scum, and efflorescence; effect of drying treatment on physical properties of clay bodies. A.E.R.W.

Permanent exhibit of Bureau of Mines. ANON. *Cement, Mill & Quarry*, **34** [5], 54 (1929).—Permanent exhibit of the historical development of the welfare and safety work of the U.S. Bureau of Mines is being prepared for the National Museum. E.P.R.

Gypsum producers adopt trade code. ANON. *Cement, Mill & Quarry*, **34** [5], 27–29 (1929). E.P.R.

The college, its graduates, and the industries. W. B. PLANK. *Min. and Met.*, **10** [269], 234–36 (1929).—P. discusses what the college expects of the operating companies in receiving and training its graduates. F.P.H.

Operating companies vs. college graduates. L. E. YOUNG. *Min. and Met.*, **10** [269], 238–39 (1929).—What the operating company expects of the college graduate is discussed. F.P.H.

Discussion of papers on engineering education. ANON. *Min. and Met.*, **10** [269], 240–45 (1929). F.P.H.

Value of first aid training. W. D. RYAN. *Cement, Mill & Quarry*, **34** [5], 30 (1929).—During 1928 fatal accidents rose to 100,000, about equally divided between industrial plants, automobiles, and accidents in the homes. Accidents are sixth among causes of deaths and third as a cause of death among men. E.P.R.

Mine timber. W. D. HALEY. *Trans. Can. Inst. Min. and Met.*, **30**, 1177–87 (1927).—The conservation, preparation, storage, and treatment of mine timber are described. F.P.H.

World economic conditions. ANON. *Cement, Mill & Quarry*, **34** [5], 59 (1929).—The National Industrial Conference Board, New York, has brought out "A Picture of World Economic Conditions," the title of which is self-explanatory. It provides a résumé of economic conditions in 18 important countries by nine principal editors aided by a score of correspondents. E.P.R.

Chemistry students in Germany. SCHARF. *Chem. and Ind.*, **48**, 377 (1929).—There has been a large drop in the number of chemistry students in Germany during the last three years. In 1925, there were 3693 at the Universities and 2415 at the Technical "Hochschule;" for 1928, the figures were 2679 and 1601. The time required for qualification in chemistry is regarded as abnormally long, but the overcrowding of the profession is also to blame. H.H.S.

German potash sales. ANON. *Nat. Glass Budget*, **44** [49], 23 (1929).—The favorable Franco-German potash agreement can be seen in the price increase and business of the German potash industry in 1928, which set a sales record of 1,420,000 metric tons of potash K_2O content. E.P.R.

Clay studies by the Osram laboratory. E. ZSCHIMMER. *Sprechsaal*, **62** [10], 165–68 (1929).—Data on plasticity, tempering water, drying shrinkage, firing shrinkage, porosity, and fusion point of the well known German and Austrian fire clays are given. T.W.G.

Occurrence, winning, and properties of kaolin at Schoenhaide. E. KIEFFER. *Sprechsaal*, **61** [48], 941–43 (1928). T.W.G.

Tare weight as a factor in sales. H. G. MACKELCAN. *Chem. Markets*, **24**, 507–509 (1929).—Not only does the often-disregarded item of tare in shipments involve thousands of dollars, but it has encouraged abuses out of conformity with good practice. H.H.S.

Ceramic industry in Egypt. ANON. *Chem. and Ind.*, **48**, 424 (1929).—There is an abundance of clay, gypsum, etc., along the banks of the Nile, and in consequence of the building developments in the principal towns, and of the sanitary reforms in Egypt, all classes of the ceramic industry are active. The largest factory in the country is that of S. Sornaga at El Wedy, 50 mi. up the Nile from Cairo. It covers 14 acres and employs 1500, nearly all natives. Brick for building and for furnace work, sanitary goods,

pottery, and semiporcelain are all made here. Another factory makes sand-lime brick; its daily output is 90,000. Portland cement is made at Massara, 12 mi. from Cairo. The country requires 250,000 T. of cement annually, and of this the Société de Ciment d'Egypte makes 50,000. All necessary raw materials are obtained locally. H.H.S.

Building in the electrical age. ANON. *Cement, Mill & Quarry*, **34** [5], 64 (1929).—The part which electrification is taking in modern buildings is portrayed comprehensively. Illustrations are given of many of the leading buildings in the country, together with views of the Westinghouse equipment installed. E.P.R.

Factory floors. F. HERON ROGERS. *Pottery Gaz.*, **54** [623], 769–71(1929).—Many engineering problems are outlined and discussed, such as the suitability of site, the treatment of the ground soil, drainage, safe load factor, etc. Constructional materials for ground floors, classification of the different types and enumeration of the advantages and disadvantages of each variety are also given. Although the designer is confined to concrete as a base for the floor, he is not so limited in the choice of constructional materials for the floor itself. A rough classification of ground floors might be said to be: (*a*) solid nonresilient floors of concrete, stone mosaic, ceramic ware or brick, which are footheat conductors; (*b*) more resilient floors of tarred macadam, asphalt, bitumen or pitch-dressed; (*c*) semi-elastic floors of wood blocks, parquet, and similar materials, which are reasonably nonheat-conducting; and (*d*) wood plank floors, which are resilient and comparatively nonheat-conducting. For wear, (*a*) and (*b*) were superior to (*c*) and (*d*), but the latter gave a maximum of comfort and ease to the operative. Apart from these considerations, however, each type had its own features of advantage and disadvantages. The various types of floors are discussed in greater detail. E.J.V.

Buyer vs. seller. LEO. T. PARKER. *Brick Clay Rec.*, **74** [10], 668–70 (1929).—A discussion of the law regarding the rights and liabilities of the buyer and seller in the sale of clay products, as handed down from the higher courts. E.J.V.

Intra-plant standardization. P. E. HOLDEN. *Ceram. Age*, **12** [3], 97–100 (1929).—Despite the tremendous savings accomplished by nation-wide effort at simplification and standardization, many individual plants have not fully realized the possibilities afforded by intelligent intra-plant standardization. Material, equipment, processes, etc., are discussed. A.E.R.W.

Making the plant physically safe. W. GRAHAM COLE. *Glass Ind.*, **10** [4], 92d (1929).—Accident prevention in plants is discussed. Requirements made by law in most states, as well as by casualty insurance companies, require ample provision for public safety in plants, and where such requirements are not in force as yet it is only a matter of time before they will be put into effect. Guards on machinery are discussed in general. E.J.V.

Merger of English pottery firms. ANON. *Crockery & Glass Jour.*, **107** [5], 69 (1929).—It was reported that a group of financiers have made offers to a large number of pottery firms to buy a substantial interest with the view of forming a large corporation with capital of from £2,000,000 to £3,000,000 (about $10,000,000 to $15,000,000). It was said that 26 out of 40 members of the English China Mfrs. Assn. including some of the leading firms, had agreed to the amalgamation. E.P.R.

Independence vs. the merger. CARTER D. POLAND. *Brick Clay Rec.*, **74** [10], 662–63 (1929).—An independent manufacturer gives the advantages of privately-owned plants. E.J.V.

Economic reactions of mergers. SHERMAN CORP. *Ceram. Age*, **12** [3], 106–107 (1928).—The factors causing mergers, and the conditions under which they are economically sound are pointed out. Conclusions drawn from survey of several hundred investment bankers are given. A.E.R.W.

Federal trade practice conference. II. The Face Brick Conference. WILLIAM

C. KOCH. *Brick Clay Rec.*, **74** [10], 674–76 (1929).—An examination is made of the Trade Practice Conference of the face brick industry held on March 14, 1929. K. discussed what this conference did and what it should and will mean to the industry. E.J.V.

National Metal Exposition, 1928. ANON. *Fuels and Fur.*, **6** [11], 1537–42 (1928).—Among the exhibits at the National Metal Exposition, Philadelphia, Pa., Oct. 8, 1928, were new furnaces and furnace equipment, refractory brick and shapes, control instruments, etc. A.E.R.W.

New science institute in China. ANON. *Ceram. Age*, **12** [4], 152–153 (1928).—The National Research Institute of China is patterned after the Smithsonian Institute. Thirty outstanding scientists of China are members. The progress of scientific excavation in China is described. The tradition concerning the legendary Emperor Shun, who is supposed to have been a potter, is outlined. A.E.R.W.

Annual meeting of U. S. Potters Association. ANON. *Ceram. Age*, **12** [6], 212 (1928). A.E.R.W.

Society of Glass Technology. ANON. *Pottery Gaz.*, **54** [623], 779–82 (1929).—At the meetings held Feb. 20, Mar. 20 and April 17, 1929, the following papers were presented: "Heat-Resisting Steels, with Special Reference to their Application in the Glass Industry," by R. J. Sarjant; "Note on the Homogeneity of Small Scale Meltings in Platinum," by Violet Dimbleby, H. W. Howes, and W. E. S. Turner; "An Observation on Professor Le Chatelier's Equation for the Viscosity of Glass," by F. W. Preston; "The Erosion of Tank Blocks," by F. F. Bryson; and "Glass: Cut and Engraved," by Walter Butterworth. E.J.V.

BOOKS

Catalogue of Plans of Abandoned Mines. Vol. II. DEPT. OF MINES. H. M. Stationery Office, London, 1929. Price 15*s*. The volume covers the counties of Cornwall, Devon, Dorset, Gloucester, Kent, Somerset, Stafford, and Worcester. The primary object in preparing the catalog has been to assist those engaged in mining to deal with accumulations of water and other problems which may arise from the proximity of old workings. Prospectors also are informed on the question of surface subsidences. The volume contains 4000 plans. Reviewed in *Chem. News*, **138**, 269–70 (1929). H.H.S.

New feldspar mill of the U. S. Feldspar Corporation. ANON. *Ceram. Age*, **12** [4], 161–62 (1928).—A new mill unit of the continuous type, located at Cranberry Creek, N. Y., is described in detail. Illustrated. A.E.R.W.

Building a bottle business direct by mail. B. C. REBER. *Glass Ind.*, **10** [4], 92–93 (1929).—The use of nothing but direct mail advertising by the Three Rivers Glass Co. of Three Rivers, Texas, in building up and greatly increasing their glass bottle and container business is discussed. The development of a business of $16,526 in volume in 1923 to one having an approximate volume of $573,500 in 1928 tells of the success of this plan, which was also used in floating a bond issue for the purpose of enlarging the plant. E.J.V.

Life of Atholl McBean. ANON. *Brick Clay Rec.*, **74** [9], 608–10 (1929).—A brief biographical sketch of the president and general manager of Gladding-McBean & Co., one of the outstanding men in the clay products industry is given. E.J.V.

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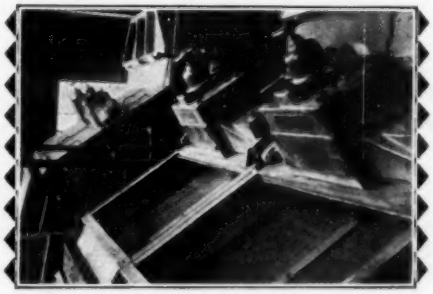

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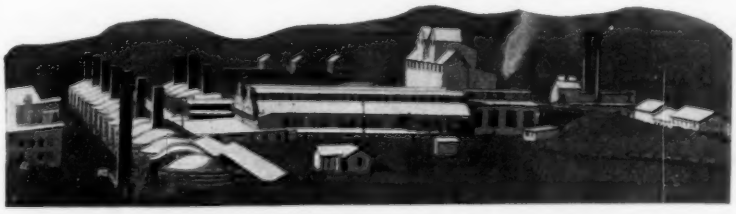

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Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering, COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in co-operation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate

THREE INSTRUCTORS *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT — *Curriculum*—Ceramic Technology and Engineering

TWO INSTRUCTORS — *Founded 1923* — *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering

TWO INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applied to ceramic manufacture

TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Founded 1926* — *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering — *Head of Department:* J. W. WHITTEMORE

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries

Founded 1926 — *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY

Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries

THIRTEEN INSTRUCTORS — *Head of Department:* JAMES R. HOPKINS

Founded 1927 — *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA

NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts — *Curriculum—Ceramic Art*

Founded 1927 — *Head of Department:* JOHN N. FRANK

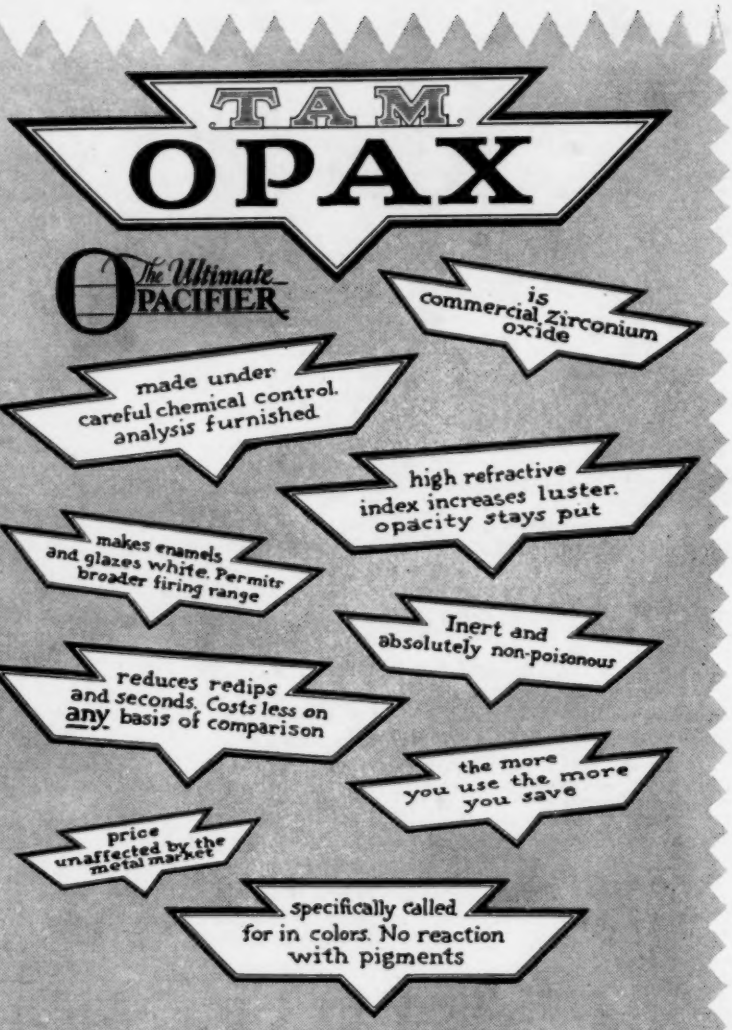
UNIVERSITY OF ALABAMA

UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

Curriculum—Technical ceramic courses given by Dept. of Chemistry and Metallurgy

TWO INSTRUCTORS — *Director:* STEWART J. LLOYD *Ceramics:* T. N. MCVAY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makes enamels and glazes white. Permits broader firing range
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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

E. DEF. CURTIS, MARION FOSDICK, J. E. HANSEN, W. V. KNOWLES	Art, Enamel	J. T. LITTLETON, G. W. MOREY, E. H. VAN SCHOICK, DOROTHY A. TEXTER, R. F. SHERWOOD, E. H. FRITZ	Glass, Refractories, White Wares	SAMUEL J. McDOWELL, H. D. CALLAHAN	Terra Cotta
				ELLSWORTH P. OGDEN, HOWELLS FRÉCHETTE	Heavy Clay Products

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Vol. 8 **July, 1929** **No. 7**

EDITORIALS

MASONRY ENGINEERING

Colleges, generally, have lecture and laboratory courses on stone, wood, and concrete construction. A great deal of engineering data are published annually and the architects and civil and mechanical engineers graduate into their professions with a knowledge and a library of data on stone, wood, and concrete, but not on ceramic construction materials.

Brick, tile, terra cotta, floor tile, wall tile, and other ceramic building material producers have not worked with the universities and experiment stations as have the producers of other building materials; hence, in building codes, engineering data books, and in the minds of engineers, ceramic structural products are placed at a decided disadvantage and are far from being valued at their true availability.

The few dimension standards are also at odds with masonry practice and not in conformity with the standards of other building materials. The result is that walls do not have strength which could be had from brick, tile, or terra cotta, and the designers depend upon variation in joints and in the mason's cutting to make the ceramic materials fit into the designed structure. This causes structural weakness at window and door openings and altogether too many cracked brick and tile walls.

It is high time that ceramic building material producers work with the universities, government laboratories, and engineering bodies to establish training of students in the use and value of ceramic materials and in the procurement of data and standards that will place ceramic building materials in the high place they really merit, but not demonstrated for construction purposes.

SOME COMMENCEMENT DAY THOUGHTS

Be yourself; different if need be.

Contemn majorities, yet be a willing team worker.

Be proud, yet slave with and for others.

Develop individual and independent ideas, yet do not hesitate to use those of others.

Do and conserve for yourself, yet invest liberally in associated affairs.

Respect centralized control as a necessity, yet coördinate and maintain individualism.

A strong constructive-minded executive is essential in collective enterprises. Help him.

Respectability too often is dullness, and being without energy.

Energy is power in man as in machines. Generate it for yourself.

Coasting on one's knowledge and ability is going backward; it takes expenditure of energy to climb to larger abilities, service, and personal happiness.

Brush made electricity available for power and for street lighting because he would not coast on his job as metallurgical chemist.

Brush studied, thought, and experimented outside of the charted confines of his job.

We must work with others; to achieve and accumulate the most we must have organized means for working together.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM MAY 1 TO JUNE 1*

CORPORATION

Ross-Tacony Crucible Co., Tacony, Philadelphia, Pa., Charles C. Bacon, representative.

PERSONAL

John Ewart Beswick, Gold St., Longton, Staffs, England, General Manager, John Beswick Co.

Carle, Frank Joesph, Vice-President, D'Hanis Brick & Tile Co., D'Hanis, Texas.

G. E. Carlyle, President, The Carlyle-Labold Co., Portsmouth, Ohio.

John N. Carothers, 501 Keith Ave., Anniston, Ala., Vice-President, Federal Phosphorus Co.

Parker Cook, Secretary, Maryland Glass Corporation, Bromo-Seltzer Tower Bldg., Baltimore, Md.

A. Vincent Joseph Dennis, 217 King St., Fenton, Stoke-on-Trent, England, Assistant Manager, Messrs. Dennis (Fenton), Ltd.

M. William Haenke, Ipswich, Queensland, Australia.

T. Hoshino, Manager, Toyo Toki Kaisha, Ltd., Kokura, Japan.

W. A. Howell, President and General Manager, Collingwood Brick & Clay Co., Toledo, Ohio.

C. H. Kallstedt, Sales Manager, Western United Gas & Electric Co., 50 Fox St., Aurora, Ill.

Paul G. Kates, 618 Superior Ave., Dayton, Ohio, Porcelain Department, Frigidaire Corporation.

Archer L. Matthes, 187 E. 4th St., Mansfield, Ohio, General Foreman, Finishing Department, Westinghouse Electric & Mfg. Co.

Nelson McCoy, 725 Forest Ave., Zanesville, Ohio, President, Nelson McCoy Sanitary Stoneware Co., Roseville, Ohio.

Louis T. Meyer, 3190 S. Kingshighway Blvd., St. Louis, Mo., President, Superior Press Brick Co.

Irma Rhodes, 5428 Murdoch Ave., St. Louis, Mo., Petrologist, Laclede-Christy Clay Products Co.

Roger W. Rowland, President, New Castle Refractories Co., New Castle, Pa.

Edward Sadler, Newlands, Watlands Ave., Wolstanton, Stoke-on-Trent, England, Director, J. Sadler & Sons, Ltd.

Ronald W. Sherwin, H. R. Johnson, Ltd., Tunstall, Staffs, England.

G. J. Steele, 500 Greenwoods Ave., Toronto, Ont., Canada, President, Standard Brick Co., Ltd.

Norman C. Weis, 316 Blackburn Ave., Ashland, Ky., Superintendent, Ashland Fire Brick Co.

STUDENT

Joseph W. Donegan, Rutgers University, New Brunswick, N. J.

Gerald W. Hofstetter, Ohio State University, Columbus, Ohio.

Harlow G. Jones, Missouri School of Mines and Metallurgy, Rolla, Mo.

Robert A. Schoenlaub, Ohio State University, Columbus, Ohio.

John T. Sellers, Ohio State University, Columbus, Ohio.

Stephen T. Spires, Ohio State University, Columbus, Ohio.

Membership Workers' Record

PERSONAL		CORPORATION	
Cecil E. Bales	1	Office	1
George Blumenthal, Jr.	1	STUDENT	
J. L. Crawford	1	G. H. Brown	1
Philip Heuisler	1	Warren F. Copp	2
Gordon C. Keith	1	C. M. Dodd	1
Wm. V. Knowles	1	A. S. Watts	2
Sidney McCann	1		
Office	13	Total	6
Total	20	Grand Total	27

* Through an error, **Norman W. Kelch**, 611 Architect's Bldg., Los Angeles, Calif., Secretary-Treasurer, Clay Products Institute of Calif., was listed in the June *Bulletin*, **Norman W. Welch.**

NOTES AND NEWS

PERMANENT COMMITTEE ON SIMPLIFICATION OF VARIETY AND STANDARDS OF VITRIFIED PAVING BRICK[1]

The Permanent Committee on Simplification of Variety and Standards of Vitrified Paving Brick met at Washington, Friday, April 19, 1929, at the United States Department of Commerce Building.

In attendance at this meeting were the following:

Mr. Rhine, representing the U. S. Bureau of Public Roads (proxy for P. St. J. Wilson).

H. R. Colwell, representing the Division of Simplified Practice, U. S. Dept. of Commerce.

R. Keith Compton, representing the American Society of Civil Engineers.

T. R. Lawson, representing the American Society for Testing Materials.

E. W. McCulloigh, representing the U. S. Chamber of Commerce.

O. W. Renkert, representing the AMERICAN CERAMIC SOCIETY.

Mr. Raschig, representing the American Association of State Highway Officials (proxy for R. N. Waid).

Geo. F. Fisk, representing the American Society for Municipal Improvements.

G. F. Schlesinger, representing the National Paving Brick Mfrs. Association.

Mr. Schlesinger, who had been elected Chairman of the Committee at the time he was representing the American Association of State Highway Officials, offered his resignation as Chairman, which was accepted by the Committee. The reason for this action was because the National Paving Brick Manufacturers Association does not consider it advisable that anyone connected directly with the industry should head this committee, which is composed in large majority of representatives of engineering, and other organizations who are interested in the simplification of sizes and varieties of paving brick from the standpoint of the utilization of this material in the design and construction of pavements.

George F. Fisk, Commissioner of Public Works of Buffalo, New York, was elected Chairman of the Committee to succeed Mr. Schlesinger.

Additional Variety Added

After carefully examining the Report of the 1928 Variety Survey, which was prepared by the National Paving Brick Manufacturers Association, it was decided to reinstate the following variety: 3- x $3^1/_2$- x $8^1/_2$-inch Wire Cut Lug Brick (Dunn). This type, in 1928, constituted 14.5% of the total shipments of all paving brick, and had shown a steady increase in the last three years. It was the consensus of opinion, that the increase in the use of this type reflected the demand of engineers for a lug brick.

This action of the Committee established the following varieties and sizes as recognized types and sizes for the ensuing year:

Wire-Cut Lug Brick (Dunn)	4 x $3^1/_2$ x $8^1/_2$ in.
	3 x $3^1/_2$ x $8^1/_2$ in.
Repressed Lug Brick	4 x $3^1/_2$ x $8^1/_2$ in.
Plain Wire-Cut (Vertical Fiber Lugless)	$2^1/_2$ x 4 x $8^1/_2$ in.
	3 x 4 x $8^1/_2$ in.
	$3^1/_2$ x 4 x $8^1/_2$ in.

These six varieties comprised 84.6% of the total shipments in 1928.

Next Meeting

The Committee decided that the usual annual meeting should be scheduled for next year, and passed a resolution thanking this Associa-

[1] Submitted by O. W. Renkert, President and General Manager, The Metropolitan Paving Brick Company, Canton, Ohio.

tion for preparing the Report of the Variety Survey, and requested it to again compile this information for the year 1929.

The Simplification of the Varieties and Standards of Vitrified Brick was the initial project of this kind started by the U. S. Department of Commerce at the time President Hoover was Secretary of Commerce. It is considered by the Department as one of its most important accomplishments in the elimination of waste in industry.

PAVING BRICK INSTITUTE ORGANIZED AT ROSEVILLE

A group of paving brick men representing the plant operators of the National Paving Brick Association were called together at the Roseville Experiment Station by the Ohio Ceramic Assn. on May 24, for the purpose of organization. It has been some years since the plant men held regular meetings as a separate group, but a desire for reorganization was engendered by the feeling that the national body allots too little time for consideration of plant problems. The additional advantage derived from more frequent meetings was realized and organization was further stimulated by the realization of the availability of the Roseville Station for research and plant proving.

With R. B. Keplinger presiding organization was begun by adopting the name, The Paving Brick Institute. The purpose of the Institute was expressed as being that of solving the manufacturing and technical problems which present themselves in the manufacture of paving brick. Provision was made to retain national identity. The right of active membership will be offered to the operators of all companies in good standing in the N. P. B. M. A. Associate and honorary membership was also provided for. At least four meetings will be held annually, with others when deemed necessary. An executive committee was appointed and empowered to present slates of officers at the meeting, and also to frame the by-laws necessary for governing the Institute.

After the business of organization was completed, plant topics were discussed. Means of association with the Ohio State University, Engineering Experiment Station was outlined.

The following were present at the meeting: C. V. Henderson, Cleveland Brick & Clay Co., R. F. Robinson, H. W. Larimer, Hocking Valley Brick Co., H. M. Bristor, H. H. Campbell, Toronto Fire Clay Co., C. C. Cooper, Euclid Shale Brick Co., William Gibson, Cleveland Shale Brick Co., R. F. Ewing, S. C. Porter, Globe Brick Co., L. C. Yohe, Bert Shroeder, R. B. Keplinger, Roy C. Wallis, Metropolitan Paving Brick Co., E. F. Rinehart, T. A. Young, State Brick Plant, Junction City; G. A. Bole, H. C, Harrison, R. E. Birch. J. Otis Everhart, Ohio State University, Engineering Experiment Station.

NEW JERSEY CLAYWORKERS' ASSOCIATION

The summer meeting of the New Jersey Clayworkers' Association was held at the Berkeley-Carteret Hotel, Asbury Park, N. J. on Friday, June 14, 1929.

The morning session was devoted to a discussion of early New Jersey ceramics and the feasibility of establishing a historical museum of New Jersey Ceramic products. The afternoon was spent in a golf tournament, bridge, and swimming.

CERAMIC SCHOOL NOTES

Open House Show of the Department of Ceramic Engineering, Iowa State College

The department of Ceramic Engineering at Iowa State College presented an Open House display during the spring term. W. L. Kenagy, president of the Student Branch

of the AMERICAN CERAMIC SOCIETY solicited for exhibitions of finished products and raw materials from the alumni. He was assisted by Gerritt Wormhoudt, newly elected president of the Student Section and also by the student members of the department.

About 3000 paper weights, the shape of the map of Iowa, made by the casting process from Iowa clay, glazed in tin enamel, and lettered to indicate the occasion were presented to the visitors. A decorated vase, valued at $25, was given as a prize, in a guessing contest. A feature of the show was an illusion called "The Magic of Ceramics." In a darkened chamber the visitors saw a mass of clay, roughly modelled into a crude vase, slowly appear; this merged into a procelain vase, glazed with copper red glaze. The design of a girl appeared on the vase, grew into life, moved and smiled, and the girl and vase slowly disappeared.

The exhibits sent by the various corporations become permanent property of the department and are valuable educational material. A catch feature was a case with false teeth and red clay door knobs containing a card "Ceramic engineers make every thing from false teeth to door knobs."

An appropriation has been made to the Ceramic Engineering Department for remodeling and enlarging the department quarters. Additional equipment will be installed after the repairs are completed.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1930	Des Moines, Iowa
AMERICAN CERAMIC SOCIETY	Feb. 17–22	Toronto, Canada
American Gas Association	Oct. 14–18	Atlantic City, N. J.
American Inst. Chemical Engrs.	Dec. 2–4	Asheville, N. C.
Amer. Inst. Mining & Metallurgical Engrs.	Oct. 7–9	San Francisco, Calif.
American Society of Mechanical Engineers	Dec. 2–6	New York, N. Y.
11th Natl. Metal Exposition and Natl. Metal Congress	Sept. 9–13	Cleveland, Ohio
Natl. Assn. of Manufacturers	Oct. 14–16	New York, N. Y.
Natl. Glass Distributors Assn.	Dec. 3–5	Pittsburgh, Pa.
Natl. Safety Council's 18th Annual Safety Congress	Sept. 30–Oct. 4	Chicago, Ill.

MEMBERSHIP ROSTER OF AMERICAN CERAMIC SOCIETY

Honorary

Czechoslovak Ceramic Society, Rudolf Barta, Secretary, Prahall 1588, Czechoslovakia.
Deutsche Keramische Gesellschaft, Mr. Behrend, Secretary, Wegelystr. 1, Berlin, N. W. 87, Germany.
English Ceramic Society, Dr. J. W. Mellor, Hon. Secretary, North Staffordshire Technical College, Stoke-on-Trent, England.
Glastechnische Gesellschaft, H. Maurach, Secretary, Gutleutstrasse 8, Frankfurt, a. M., Germany.
Harshe, Robert, Art Institute, Chicago, Ill.
Keith, Gordon C., Canadian National Clay Products Assn., 49 Turner Rd., Toronto (10), Canada.
Lundell, Gustav E. F., Bureau of Standards, Washington, D. C.
Museum of Fine Arts, Edward J. Holmes, Boston, Mass.
Nederlandsche Vereeniging Von Aardewerkfabrikanten Singel 303, Dr. H. Mulderije, Amsterdam, Holland.
Robinson, Edw., Metropolitan Museum of Art, New York, N. Y.
Society of Glass Technology, Prof. W. E. S. Turner, Secretary, Darnall Road, Sheffield, England.
Syndicate des Fabricants, de Produits Ceramiques, Dr. Jean Berard, Secretary, 84 Rue d'Hauteville, Paris, France.
Turner, Professor W. E. S., The University, Darnall Road, Sheffield, England.
Whiting, F. A., Cleveland Museum of Art, Cleveland, Ohio.

Life Members

Langenbeck, Karl, 616 McGill Bldg., Washington, D. C.
Middleton, Jefferson, 3401–16th St. N. W., Apt. 23, Washington, D. C.
Orton, Edward, Jr., Standard Pyrometric Cone Co., Columbus, Ohio.
Richardson, W. D., 384 King Ave., Columbus, Ohio.

Corporations

Abbé Engineering Co., H. F. Kleinfeldt (Voter), 50 Church St., New York, N. Y.
Abrasive Co., Bridesburg, Philadelphia, Pa.
A C Spark Plug Co., Taine G. McDougal (Voter), Flint, Mich.
Akron Procelain Co., F. W. Butler (Voter), Akron, Ohio.
Alberhill Coal & Clay Co., Chas. J. Biddle (Voter), 1031 S. Broadway, Room 732, Los Angeles, Calif.
Alhambra Tile Co., J. F. Sheehy, President (Voter), Newport, Kentucky.
Alliance Clay Product Co., J. B. Wilcox (Voter), Alliance, Ohio.
Alton Barium Products Co., M. E. Turner (Voter), Alton, Ill.
Alton Brick Co., Eben Rodgers, President (Voter), Alton, Ill.
American Encaustic Tiling Co., Wm. McCoy (Voter), Zanesville, Ohio.
American Gas Assn., J. P. Leinroth (Voter), 420 Lexington Ave., New York, N. Y.
American Potash & Chemical Corp., A. A. Holmes (Voter), 233 Broadway, New York, N. Y.
American Rolling Mill Co., E. F. Lundeen (Voter), Middletown, Ohio.
American Smelting & Refining Co., 120 Broadway, Walter F. Gross, New York, N. Y. Asst. to Vice-Pres.
American Stove Co., Arthur Stockstrom (Voter), Quick Meal Stove Co. Division, St. Louis, Mo.
American Terra Cotta & Ceramic Co., Room 1746, Builders' Bldg., 228 N. La Salle St., Box 1, Chicago, Ill.
Armstrong Cork & Insulation Co., E. C. Lloyd (Voter), Lancaster, Pa.
Associated Tile Mfrs., M. A. Illing (Voter), 420 Lexington Ave., New York, N. Y.
Athletic Mining & Smelting Co., Raymond F. Orr (Voter), Fort Smith, Arkansas.
Atlantic Terra Cotta Co., J. W. Hixson (Voter), 19 West 44th St., New York, N. Y.

Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.
Ball Brothers Co., George A. Ball (Voter), Muncie, Ind.
Baltimore Enamel & Novelty Co., H. B. Little (Voter), Box E-4, Baltimore, Md.

Batchelder-Wilson Co., Ernest A. Batchelder (Voter), 2633 Artesian St., Los Angeles, Calif.
Bauer, J. A., Pottery Co., Lynn B. Bernheim (Voter), 415 West Ave. 33, Los Angeles, Calif.
Bausch & Lomb Optical Co., John C. Kurtz (Voter), Rochester, N. Y.
Beach Enameling Co., H. L. Beach (Voter), Coshocton, Ohio.
Beaver Refrigerator & Potteries Co., A. R. Mitchell, Mgr. (Voter), New Brighton, Pa.
Bedford Mining Co. Inc., Leo L. Hunt, Bedford, N. Y.
Benjamin Electric Mfg. Co., A. E. Clarke (Voter), Des Plaines, Ill.
Binks Spray Equipment Co., M. S. Sullivan (Voter), 3114 Carroll Ave., Chicago, Ill.
Booth Brick, Geo. W. Booth (Voter), New Toronto, Ont., Canada.
Bryce Brothers Co., G. S. Bryce (Voter), Mt. Pleasant, Pa.
Buckeye Clay Pot Co., A. S. Zopfi (Voter), Toledo, Ohio.
Buckwalter Stove Co., J. A. Buckwalter (Voter), Royersford, Pa.
Buffalo Pottery, L. H. Bown, General Manager (Voter), Buffalo, N. Y.

Cambridge Sanitary Mfg. Co., J. W. Whittaker (Voter), Cambridge, Ohio.
Canadian General Electric Co. Ltd., E. Rigby, Supt. (Voter), Peterborough, Canada.
Canonsburg Pottery Co., W. C. George (Voter), Canonsburg, Pa.
Canton Brick & Fireproofing Co., New Philadelphia, Ohio.
Canton Stamping & Enameling Co., E. F. Hoerger (Voter), Canton, Ohio.
Carborundum Co., Frank J. Tone (Voter), Niagara Falls, N. Y.
Carr-Lowrey Glass Co., Geo H. Slater (Voter), Baltimore, Md.
Central Alloy Steel Corp., F. M. Portz (Voter), Massillon, Ohio.
Central of Georgia Railway Co., J. M. Mallory (Voter), Savannah, Ga.
Challenge Refrigerator Co., E. O. Harbeck (Voter), Grand Haven, Mich.
Champion Porcelain Co., Jos. A. Jeffery (Voter), Butler Ave. & Grand Trunk R. R., Detroit, Mich.
Chase Foundry & Mfg. Co., A. J. Dunn, Sales Manager & Second Vice-President (Voter), Columbus, Ohio.
Chattanooga Stamping & Enameling Co., James E. Abshire (Voter), Chattanooga, Tenn.
Chicago Crucible Co., A. F. Hottinger (Voter), 2525 Clybourn Ave., Chicago, Ill.
Chicago Hardware Foundry Co., J. A. De Celle (Voter), N. Chicago, Ill.
Chicago Pottery Co., F. J. Clifford, President (Voter), 1924 Clybourn Ave., Chicago, Ill.
Chicago Retort & Fire Brick Co., Henry Tanner (Voter), 208 S. La Salle St., Chicago, Ill.
Claycraft Mining & Brick Co., C. Forrest Tefft (Voter), 907 Hartman Bldg., Columbus, Ohio.
Clay Products Association, Geo. D. Lenth (Voter), Room 1847–111 W. Washington, Box 2, Chicago, Ill.
Clay Products Inc., George Shoemaker, Vice-President (Voter), Brazil, Ind.
Columbia Enameling & Stamping Co., Wm. M. Gorby, Superintendent (Voter), Terre Haute, Ind.
Commercial Shearing & Stamping Co., R. V. Proctor (Voter), 1775 Logan Ave., Youngstown, Ohio.
Conkling-Armstrong Terra Cotta Co., Thos. F. Armstrong (Voter), Wissahickon Ave. & Juniata St., Philadelphia, Pa.
Consolidated Slip Clay Corp., E. J. B. Murray, Vice-President (Voter), 295 W. Laurence St., Albany, N. Y.
Coors Porcelain Co., A. Coors, Jr. (Voter), Golden, Colo.
Corhart Refractories Co., Inc., Fred S. Thompson (Voter), 16th & Lee Sts., Louisville, Ky.
Corning Glass Works, E. C. Sullivan (Voter), Corning, N. Y.
Cortland Grinding Wheel Co., C. B. Tilton (Voter), Chester, Mass.
Corundite Refractories, Inc., H. R. Orwick (Voter), Massillon, Ohio.
Cowles Detergent Co., E. S. Bassett (Voter), 7016 Euclid Ave., Cleveland, Ohio.
Crane Enamelware Co., A. M. Nelson (Voter), Chattanooga, Tenn.
Crescent China Co., C. F. Baker (Voter), Alliance, Ohio.
Crossley Machine Co., D. M. Miller (Voter), Trenton, N. J.
Crossman Company, Chas. W. Crane, President (Voter), South Amboy, N. J.
Crown Potteries Co., Evansville, Ind.

Denver Sewer Pipe & Clay Co., Wm. J. Geddes (Voter), Broadway at Curtis, Denver, Colo.
Detroit Star Grinding Wheel Co., F. H. Whelden (Voter), 111 Cavalry Ave., Detroit, Mich.
Detroit Vapor Stove Co., A. G. Sherman (Voter), Detroit, Mich.
Devilbiss Mfg. Co., Frank A. Bailey (Voter), Toledo, Ohio.
W. S. Dickey Clay Mfg. Co., N. A. Dickey (Voter), 604 Mission St., San Francisco, Calif.
H. L. Dixon Co., D. W. Loomis (Voter), Box 140, Pittsburgh, Pa.
Joseph Dixon Crucible Co., H. P. Smith (Voter), Jersey City, N. J.
Dolomite, Inc., H. P. Eells (Voter), 1510 Hanna Bldg., Cleveland, Ohio.
B. F. Drakenfeld & Co., B. F. Drakenfeld (Voter), 45–47 Park Place, New York, N. Y.
Dudgeon, Richard, Inc., James Moore (Voter), 82 Droome St., New York, N. Y.

East Liverpool Potteries Co., Bernard S. Purinton (Voter), Wellsville, Ohio.
Edgar Plastic Kaolin Co., D. R. Edgar (Voter), Metuchen, N. J.
Electrical Refractories Co., C. W. Williams, President (Voter), East Clark St., E. Palestine, Ohio.
Electrical Testing Laboratory, H. H. Millar (Voter), 80th St. & East End Ave., New York, N. Y.
Electro-Alloys Co., J. B. Thomas (Voter), Taylor St., Elyria, Ohio.
Empire Steel Corp., Chas. H. Stamm (Voter), Mansfield, Ohio.
Engelhard, Charles, Inc., R. N. Newcomb (Voter), 90 Chestnut St., Newark, N. J.
English China Clays Sales Corp., Sigmund Goldman (Voter), 551 Fifth Ave., New York, N. Y.
Enterprise White Clay Co., Frederick Stanger (Voter), Real Estate Trust Bldg., Philadelphia, Pa.
Eureka Flint & Spar Co., F. W. Thropp (Voter), Box 266, Trenton, N. J.

Federal Abrasives Co., Robert Weatherly, Sales Manager (Voter), Birmingham, Ala.
Federal Electric Co., Lee Hall (Voter), 8700 S. State St., Chicago, Ill.
Federal Seaboard Terra Cotta Co., E. V. Eskesen, President (Voter), Perth Amboy, N. J.
Federal Seaboard Terra Cotta Co., South Amboy, N. J.
Ferguson, H. K., Co., H. S. Jacoby (Voter), Hanna Bldg., Cleveland, Ohio.
Fiske & Co., Inc., James W. Libby (Voter), 115 Federal St., Boston, Mass.
Foote Mineral Co., H. C. Meyer (Voter), 1609 Summer St., Philadelphia, Pa.
Edward Ford Plate Glass Co., C. E. Husted (Voter), Rossford, Ohio.
Fords Porcelain Works, Abel Hansen (Voter), Perth Amboy, N. J.
Fostoria Glass Co., W. F. Curtis (Voter), Moundsville, W. Va.
Fraunfelter China Co., G. E. Fraunfelter, President (Voter), Zanesville, Ohio.
Frontenac Floor & Wall Tile Co. Ltd., Everett Townsend (Voter), P. O. Box 178, Kingston, Ontario, Canada.

R. Gaertner & Co., Inc., Rudolf Gaertner (Voter), 200 Fifth Ave., New York, N. Y.
Garfield Fire Clay Co., F. E. Robinson (Voter), Robinson, Pa.
General Ceramics Co., Lewis Albrecht (Voter), 225 Broadway, New York, N. Y.
W. S. George Pottery Co., W. S. George (Voter), East Palestine, Ohio.
Gillinder Bros., Inc., James Gillinder (Voter), Port Jervis, N. Y.
Gladding McBean & Co., Atholl McBean, Secretary (Voter), 660 Market St., San Francisco, Calif.
Gladding, McBean & Co., Paul S. MacMichael (Voter), 1500 First Ave. South, Seattle, Wash.
Gladding, McBean & Co., F. B. Ortman (Voter), 621 S. Hope St., Los Angeles, Calif.
Gleason-Tiebout Glass Co., C. H. Tiebout, Jr. (Voter), 99 Commercial St., Brooklyn, N. Y.
Glenwood Range Co., J. L. Anthony (Voter), Taunton, Mass.
Globe Brick Co., F. G. Porter (Voter), Box 765, East Liverpool, Ohio.
Golding-Keene Co., Charles E. Golding (Voter), Keene, N. H.
Golding Sons Co., Herbert P. Margerum (Voter), 1005 Trenton Trust Bldg., Trenton, N. J.
A. P. Green Fire Brick Co., A. P. Green, President (Voter), Mexico, Mo.

Haeger Potteries, Inc., E. H. Haeger (Voter), Dundee, Ill.
Hall China Co., M. W. Thompson (Voter), East Liverpool, Ohio.
Hanley Co., Bradford, Pa.

Hanovia Chemical & Mfg. Co., W. Riehl (Voter), Chestnut St. & N. J. R. R., Newark, N. J.
Harbison-Walker Refractories Co., Kenneth Seaver (Voter), Pittsburgh, Pa.
Hardinge Co., Inc., Francis E. Finch (Voter), York, Pa.
Harrop Ceramic Service Co., Carl B. Harrop, President (Voter), 310 W. Broad St., Columbus, Ohio.
Harshaw Chemical Co., D. T. Peny (Voter), 1610 Hanna Bldg., Cleveland, Ohio.
Hartford-Empire Co., F. Goodwin Smith, Vice-President (Voter), Box 1411, Hartford, Conn.
Hazel-Atlas Glass Co., J. H. McNash (Voter), Wheeling, W. Va.
Holcroft & Co., John T. Jans (Voter), 6545 Epworth Blvd., Detroit, Mich.
Homer Laughlin China Co., W. E. Wells (Voter), East Liverpool, Ohio.
O. Hommel Co., O. Hommel (Voter), 209–4th Ave., Pittsburgh, Pa.
Mifflin Hood Brick Co., J. W. Thomas, Vice-President (Voter), Hamilton County, Daisy, Tenn.
L. J. Houze Convex Glass Co., Roger J. Houze (Voter), Point Marion, Pa.
Humphryes Mfg. Co., F. B. Mahoney (Voter), Mansfield, Ohio.
Hydraulic-Press Brick Co., S. H. Ivery (Voter), 705 Olive St., St. Louis, Mo.

Illinois Electric Porcelain Co., C. W. Kettron (Voter), Macomb, Ill.
Illinois-Pacific Glass Co., Otto Rosenstein, Vice-President (Voter), 15th & Folsom Sts., San Francisco, Calif.
Industrial Publications, Inc., F. A. Guignon (Voter), 407 S. Dearborn St., Chicago, Ill.
Ingram-Richardson Mfg. Co., Ernest Richardson, Vice-President and Treasurer (Voter), Beaver Falls, Pa.
International Lead Refining Co., F. O. Case (Voter), 151st and McCook Ave., East Chicago, Ind.
Iron City Sanitary Mfg. Co., 1514 Oliver Bldg., Pittsburgh, Pa.
Ironclay Brick Co., Ohio Building & Loan Bldg., Columbus, Ohio.

Jeffery-Dewitt Insulator Co., J. F. Sinclair (Voter), Kenova, W. Va.

Kentucky-Tennessee Clay Co., R. C. Meeker (Voter), Paris, Tenn.
O. W. Ketcham Co., O. W. Ketcham (Voter), 125 North 18th St., Philadelphia, Pa.
Kier Fire Brick Co., P. S. Kier (Voter), 2243 Oliver Bldg., Pittsburgh, Pa.
King Machine & Mfg. Co., F. Y. Pearne (Voter), 1171 E. 32nd St., Los Angeles, Calif.
Edwin M. Knowles China Co., Harry Watkin (Voter), Newell, W. Va.
Kohler Company, W. J. Kohler (Voter), Kohler, Wis.

Laclede-Christy Clay Products Co., W. J. Westphalen (Voter), Vice-President and General Manager, 1711 Ambassador Bldg., St. Louis, Mo.
Laclede Gas Light Co., W. H. Whitton (Voter), Olive at 11th St., St. Louis, Mo.
Lapp Insulator Co. Inc., G. W. Lapp (Voter), Leroy, N. Y.
Libbey Glass Mfg. Co., H. R. Black (Voter), Toledo, Ohio.
A. J. Lindemann & Hoverson Co., W. C. Lindemann (Voter), Milwaukee, Wis.
Locke Insulator Corp., F. H. Reagan (Voter), Box A, Baltimore, Md.
Logan Clay Products Co., M. J. Cole (Voter), Logan, Ohio.
London Brick Co. & Forders, Ltd., C. W. D. Rowe (Voter), Africa House, Kingsway, London, W. C. 2, England.

McLain Fire Brick Co., J. B. Blewett (Voter), Central Office, Wellsville, Ohio.
D. E. McNicol Pottery Co., East Liverpool, Ohio.
Macbeth-Evans Glass Co., H. H. Blau (Voter), Charleroi, Pa.
Thos. Maddock's Sons Co., C. S. Maddock, Jr. (Voter), Trenton, N. J.
Maine Feldspar Co., Norman G. Smith (Voter), Brunswick, Maine.
Malleable Iron Range Co., Frederick W. Rogers (Voter), Beaver Dam, Wis.
Mansfield Vitreous Enameling Co., C. P. McFarland, Supt. (Voter), Mansfield, Ohio.
Maryland Glass Corp., Louis C. Roche (Voter), Morrell Park Sta., Baltimore, Md.
Mason City Brick & Tile Co., H. B. Keeler (Voter), Mason City, Iowa.
Matawan Tile Co., B. K. Eskesen (Voter), Matawan, N. J.
Metal & Thermit Corp., Eugen Becher (Voter), 120 Broadway, New York, N. Y.
Midland Terra Cotta Co., W. S. Primley (Voter), 16th St. and 54th Ave., Cicero, Ill.
Milton Brick, Ltd., Attn. F. R. McCannell, Milton, Ont., Canada.
Mineral Products Co., Frank P. Knight (Voter), Beverly Farms, Mass.

Mississippi Glass Co., R. D. Humphreys (Voter), 220 Fifth Ave., New York, N. Y.
Missouri Clay Mining Co., C. L. Gray (Voter), 1423 Ambassador Bldg., St. Louis, Mo.
Mitchell-Bissell Co., J. A. Williams (Voter), Trenton, N. J.
Mitchell Clay Mfg. Co., Wm. F. Knoesel (Voter), 5627 Manchester Ave., St. Louis, Mo.
Moffats, Ltd., Frederick W. Moffat (Voter), Dennison Ave., Weston, Ont., Canada.
Montgomery Porcelain Products Co., E. T. Montgomery (Voter), Franklin, Ohio.
Moore & Munger, Melville Marks (Voter), 29 Broadway, New York, N. Y.
Mosaic Tile Co., R. P. Herrold, President (Voter), Zanesville, Ohio.
Mt. Clemens Pottery Co., C. E. Doll (Voter), Mt. Clemens, Mich.
Mueller Company, A. V. Lawton (Voter), Decatur, Ill.
Mueller Mosaic Co., H. C. Mueller (Voter), Trenton, N. J.

National Airoil Burner Co., Edward P. Bailey (Voter), 1327 Girard Ave., Philadelphia, Pa.
National Enameling & Stamping Co., J. F. Blackie (Voter), P. O. Box 1400, St. Louis, Mo.
National Fireproofing Co., R. A. Shipley (Voter), 1134 Fulton Bldg., Pittsburgh, Pa.
National Lime Association, W. V. Brumbaugh (Voter), 927–15th St., N. W., Washington, D. C.
Nippon Gaishi Kwaisha, M. Ezoi, Manager (Voter), Atsuta Higashimatch, Nagoya City, Japan.
Nippon Taki Kwaisha Noritake, Jiro Isakawa (Voter), Nagoya City, Japan.
North Carolina Dept. of Conservation & Development, H. J. Bryson (Voter), Box 406, Raleigh, N. C.
Northwestern Terra Cotta Co., A. F. Hottinger (Voter), 2525 Clybourn Ave., Chicago, Ill.
Northwestern Terra Cotta Co., E. J. Dykes (Voter), West First & Umatilla Sts., Denver, Colo.
Norton Company, Arthur T. Malm (Voter), Worcester, Mass.

Ohio Power Co., A. S. Durrant, Jr. (Voter), Coshocton, Ohio.
Olean Tile Co., G. D. Phillips (Voter), Olean, N. Y.
Onondaga Pottery Co., B. E. Salisbury (Voter), Syracuse, N. Y.
Owens-Illinois Glass Co., Garland Lufkin, Chief Engineer (Voter), 965 Wall St., Toledo, Ohio.

Pacific Clay Products, Robert Linton (Voter), 650 Chamber of Commerce Bldg., Los Angeles, Calif.
Paper Makers Importing Co. Inc., Charles Brian, Vice-President (Voter), 640 N. 13th St., Easton, Pa.
Pangborn Corporation, A. M. Oliver (Voter), Hagerstown, Md.
Pass & Seymour, Inc., J. W. Brooks (Voter), Solvay, N. Y.
Pennsylvania Pulverizing Co., Wm. J. Woods (Voter), Lewistown, Pa.
Pennsylvania Salt Mfg. Co., John E. Hutchinson (Voter), 319 Union Trust Bldg., Pittsburgh, Pa.
Pfaudler Co., O. I. Chormann (Voter), Rochester, N. Y.
Phoenix Glass Co., A. H. Stewart (Voter), Monaca, Pa.
Pittsburgh Plate Glass Co., C. E. Fulton (Voter), Pittsburgh, Pa.
Plibrico Jointless Firebrick Co., W. A. Schaefer (Voter), 1130 Clay St., Chicago, Ill.
Polar Ware Co., W. J. Vollrath (Voter), Sheboygan, Wis.
Porcelain Enamel Mfg. Co., Karl Turk, Vice-President (Voter), O'Donnell & 8th Sts., Baltimore, Md.
Potters Supply Co., Dewitt C. Irwin (Voter), East Liverpool, Ohio.
Proctor & Schwartz, Inc., T. H. Rhodes (Voter), 7th St. and Tabor Rd., Philadelphia, Pa.

W. T. Rawleigh Co., W. J. Trevillian, Vice-President (Voter), Freeport, Ill.
Reading Fire Brick Works, W. McH. Boyer (Voter), Reading, Pa.
Rex Products & Mfg. Co., W. W. Davidson (Voter), 451 W. Larned, Detroit, Mich.
Dr. Rickmann & Rappe, G. m. b. H., E. Rickmann (Voter), Chemische Fabriken, Koln-Kalk, Germany.
W. A. Riddell Co., R. O. Perrott, Secretary (Voter), Bucyrus, Ohio.
River Feldspar Co., A. C. Postley (Voter), P. O. Box 673, Middletown, Conn.
Roberts & Mander Stove Co., Robert B. Schall (Voter), Hatboro, Pa.
Robertson Art Tile Co., A. D. Forst, President (Voter), Box 843, Trenton, N. J.

Roessler & Hasslacher Chemical Co., Werner Malsch (Voter), 10 E. 40th St., New York, N. Y.
Rookwood Pottery Co., Stanley G. Burt (Voter), Mount Adams, Cincinnati, Ohio.
Roseville Pottery Co., Russell T. Young (Voter), Zanesville, Ohio.
Rossman Corporation, Reeves Building, F. W. Walker, Jr., President (Voter), Beaver Falls, Pa.
Ross-Tacony Crucible Co., Charles C. Bacon, Secretary (Voter), Tacony, Philadelphia, Pa.
Rundle Mfg. Co., A. C. Held (Voter), Milwaukee, Wis.

Samuel Stamping & Enameling Co., W. L. Lane (Voter), Chattanooga, Tenn.
Sand-Lime Brick Association, Allen G. Walton (Voter), Manufacturers Club, Broad and Walnut Sts., Philadelphia, Pa.
Scranton Enameling Co., J. A. Friedel (Voter), New York St. and Jefferson Ave., Scranton, Pa.
J. M. Seasholtz Co., Front and Spruce Sts., Reading, Pa.
Sebring Pottery Co., Charles L. Sebring (Voter), Sebring, Ohio.
Shenango Pottery Co., James M. Smith (Voter), New Castle, Pa.
Simonds Worden White Co., F. R. Henry (Voter), N. Summit St. & Negley Place, Dayton, Ohio.
Simplex Engineering Co., C. E. Frazier (Voter), Washington Trust Bldg., Washington, Pa.
Smith-Phillips China Co., P. V. Robinson (Voter), East Liverpool, Ohio.
Smith & Stone, Ltd., B. Stone (Voter), Georgetown, Ont., Canada.
Southern California Gas Co., Lee Holtz (Voter), 1700 Santa Fe Ave., Los Angeles, Calif.
H. C. Spinks Clay Co., R. B. Carothers (Voter), 52 Monmouth St., Newport, Ky.
Square D Company, L. W. Mercer (Voter), Peru Plant, Peru, Ind.
Standard Dry Kiln Co., Robt. C. Eelirst (Voter), Indianapolis, Ind.
Standard Pyrometric Cone Co., Edward Orton, Jr., Proprietor (Voter), 1538 N. High St., Columbus, Ohio.
Standard Sanitary Mfg. Co., Box 1226, Bessemer Bldg., Pittsburgh, Pa.
Standard Sanitary Mfg. Co., G. C. Kalbfleisch (Voter), Tiffin Works, Tiffin, Ohio.
Star Porcelain Co., Herbert Sinclair (Voter), Trenton, N. J.
States Experimental Institute of Silicates, Moscow, U. S. S. R.
Stettiner Chamottefabrik Akt.-Ges., Westfalische Str. 90, Berlin-Wilmersdorf, Germany.
Stockton Fire Brick Co., John T. Roberts (Voter), 1267 Russ Bldg., San Francisco, Calif.
Straitsville Impervious Brick Co., John D. Martin, Manager (Voter), New Straitsville, Ohio.
Streator Brick Co , E. F. Plumb (Voter), Streator, Ill.
Surface Combustion Co., F. W. Manker (Voter), 2375 Dorr St., Toledo, Ohio.

Tavern Rock Sand Co., T. A. Graham, Vice-President (Voter), Millville, N. J.
Taylor, Smith & Taylor Co., W. L. Smith, Jr. (Voter), Chester, W. Va.
Titanium Alloy Mfg. Co., A. Thompson (Voter), Niagara Falls, N. Y.
Toyo Toki Kwaisha, S. Momoki (Voter), Shinozaki, Kokura City, Japan.
Trent Tile Co., Thos. H. Thropp (Voter), Trenton, N. J.
Trenton Potteries, John A. Campbell (Voter), Trenton, N. J.
W. S. Tyler Co., F. P. Nickerson (Voter), Cleveland, Ohio.

Ukrsilikattrust, Zinovy Tabakov (Voter), Ul. Lwanowa 27, Kharkov, U. S. S. R.
U. S. Sanitary Mfg. Co., F. J. Schuman (Voter), Monaca, Pa.
U. S. Smelting Furnace Co., Richard W. Gass (Voter), Belleville, Ill.
Universal Dental Co., Joseph Kohn (Voter), 48th & Brown Sts., Philadelphia, Pa.
Universal Sanitary Mfg. Co., W. Keith McAfee (Voter), New Castle, Pa.

R. T. Vanderbilt Co., R. T. Vanderbilt (Voter), 230 Park Ave., New York, N. Y.
Veritas Firing System, Prospect Laboratories, Trenton, N. J.
Verreries Souchon Neuvesel, Givors, Rhone, France.
Vesuvius Crucible Co., Francis L. Arensberg (Voter), Box 47, Swissvale, Pa.
Vitrefrax Company, T. S. Curtis (Voter), P. O. Box 754, Vernon Branch, Los Angeles, Calif.
Vitreous Enameling Co., Edgar H. Weil (Voter), 71st & Grant Ave., Cleveland, Ohio.
Vitro Mfg. Company, Josef Vollkommer (Voter), 927–8 Fulton Bldg., Pittsburgh, Pa.
The Vollrath Co., J. C. Vollrath (Voter), Sheboygan, Wis.

Waltham Grinding Wheel Co., M. F. Cunningham (Voter), Waltham, Mass.
Washington Porcelain Co., C. J. Rukenbrod (Voter), Washington, New Jersey.
Weber Electric Co., August Weber, Jr., President (Voter), Schenectady, N. Y.
The Wehrle Co., W. W. Wehrle (Voter), Newark, Ohio.
The West End Pottery Co., G. B. Cunning, President (Voter), East Liverpool, Ohio.
Western Electric Co., L. I. Shaw, Dept. 7434 (Voter), Hawthorne Station, Chicago, Ill.
Western Stoneware Co., I. F. Dains (Voter)Monmouth, Ill.,
West Gas Improvement Co., F. J. Kennedy, President (Voter), 441 Lexington Ave, New York, N. Y.
Westinghouse High Voltage Insulator Co., E. H. Fritz (Voter), Derry, Pa.
Westinghouse Lamp Co., Albert Brann (Voter), Bloomfield, N. J.
Wheeling Steel Corp., Carl Burkhalter (Voter), Portsmouth, Ohio.
Whitall-Tatum Co., Geo. S. Bacon (Voter), Millville, N. J.
Wolverine Porcelain Co., J. W. Hoehl, Vice-President (Voter), 3350 Scotten Ave., Detroit, Mich.

Voters for Corporations

Abshire, James E., Chattanooga Stamping & Enameling Co., Chattanooga, Tenn.
Albrecht, Lewis, General Ceramics Co., 225 Broadway, New York, N. Y.
Anthony, J. L., Glenwood Range Co., Taunton, Mass.
Arensberg, Francis L., Vesuvius Crucible Co., Box 47, Swissvale, Pa.
Armstrong, Thos. F., Conkling-Armstrong Terra Cotta Co., Wissahickon Ave. and Juniata St., Philadelphia, Pa.

Bacon, Charles C., Secretary, Ross-Tacony Crucible Co., Tacony, Philadelphia, Pa.
Bacon, Geo. S., Whitall-Tatum Co., Millville, N. J.
Bailey, Edward P., National Airoil Burner Co., 1327 Girard Ave., Philadelphia, Pa.
Bailey, Frank A., Devilbiss Manufacturing Co., Toledo, Ohio.
Baker, C. F., Crescent China Co., Alliance, Ohio.
Ball, George A., Ball Brothers Co., Muncie, Ind.
Bassett, E. S., Cowles Detergent Co., 7016 Euclid Ave., Cleveland, Ohio.
Batchelder, Ernest A., Batchelder-Wilson Co., 2633 Artesian St., Los Angeles, Calif.
Beach, H. L., Beach Enameling Co., Coshocton, Ohio.
Becher, Eugen, Metal & Thermit Corp., 120 Broadway, New York, N. Y.
Bernheim, Lynn B., J. A. Bauer Pottery Co., 415 West Ave. 33, Los Angeles, Calif.
Biddle, Charles J., Alberhill Coal & Clay Co., 1031 S. Broadway, Room 732, Los Angeles, Calif.
Black, H. R., Libbey Glass Mfg. Co., Toledo, Ohio.
Blackie, J. F., National Enameling & Stamping Co., P. O. Box 1400, St. Louis, Mo.
Blau, H. H., Macbeth-Evans Glass Co., Charleroi, Pa.
Blewett, J. B., McLain Fire Brick Co., Central Office, Wellsville, Ohio.
Booth, George W., Booth Brick, New Toronto, Ont., Canada.
Bown, L. H., General Manager, Buffalo Pottery, Buffalo, N. Y.
Boyer, W. McH., Reading Fire Brick Works, Reading, Pa.
Brann, Albert, Westinghouse Lamp Co., Bloomfield, N. J.
Brian, Charles, Vice-President, Paper Makers Importing Co., Inc., 640 N. 13th St., Easton, Pa.
Brooks, J. W., Pass & Seymour, Inc., Solvay, N. Y.
Brumbaugh, W. V., National Lime Association, 927—15th St., N. W., Washington, D. C.
Bryce, G. S., Bryce Brothers Co., Mt. Pleasant, Pa.
Bryson, H. J., North Carolina Department of Conservation & Development, Box 406, Raleigh, N. C.
Buckwalter, J. A., Buckwalter Stove Co., Royersford, Pa.
Burkhalter, Carl, Wheeling Steel Corp., Portsmouth, Ohio.
Burt, Stanley G., Rookwood Pottery Co., Mount Adams, Cincinnati, Ohio.
Butler, F. W., Akron Porcelain Co., Akron, Ohio.

Campbell, John A., Trenton Potteries, Trenton, N. J.
Carothers, R. B., H. C. Spinks Clay Co., 52 Monmouth St., Newport, Ky.
Case, F. O., International Lead Refining Co., 151st and McCook Ave., East Chicago, Ind.
Chormann, O. I., Pfaudler Co., Rochester, N. Y.
Clarke, A. E., Benjamin Electric Mfg. Co., Des Plaines, Ill.

Clifford, F. J., President, Chicago Pottery Co., 1924 Clybourn Ave., Chicago, Ill.
Cochrane, S. S., General Factories Manager, Owens Bottle Co., 1401 Nicholas Bldg., Toledo, Ohio.
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Seaboard Feldspar Corp., 430 Hearst Tower Bldg., Baltimore, Md.
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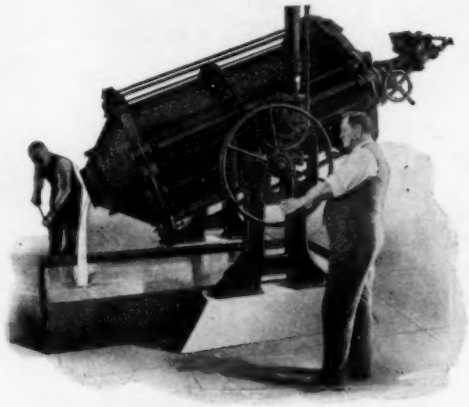

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Pacific Sanitary Mfg. Company, Richmond, California.
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B

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Roessler & Hasslacher Chemical Co.

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Pacific Coast Borax Co.

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Innis, Speiden & Co.
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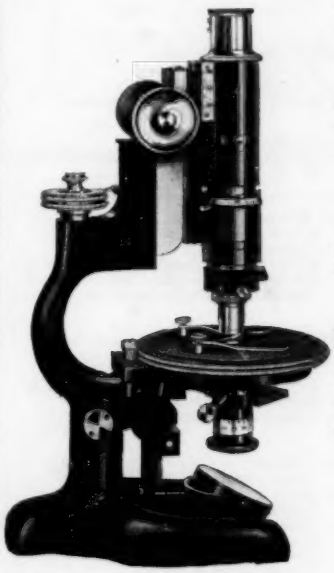

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D

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Drying Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

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Ferro Enamel Supply Co.
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Ferro Enamel Supply Co.
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Ferro Enamel Supply Co.

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F

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Flint (Imported French)
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G

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Golding Sons Company
Harshaw Chemical Co.

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Ferro Enamel Supply Co.
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Eureka Flint & Spar Co.
Golding Sons Co.
Harshaw Chemical Co.
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I

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J

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K

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Harshaw Chemical Co.
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United Clay Mines Corp.

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M

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Roessler & Hasslacher Chemical Co.

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Harshaw Chemical Co.
Roessler and Hasslacher Chemical Co.

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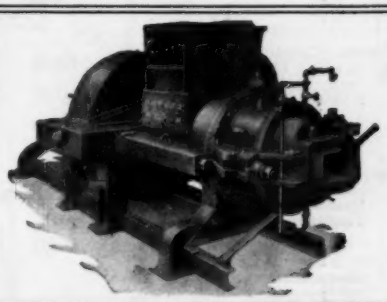

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N

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O

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Hommel Co., O.
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Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

P

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Vitro Mfg. Co.

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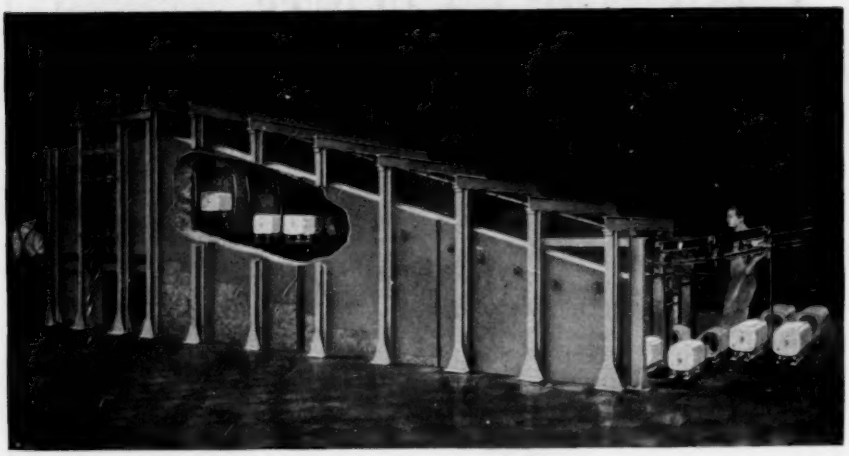

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	Page
American Potash-Chemical Corp.	**25**
American Rolling Mill Co.	**2**
American Truck & Body Co.	34
Babcock & Wilcox Co.	34
Bausch & Lomb Optical Co.	13
Brown Instrument Co.	6
Carborundum Co.	**5**
Ceramic Color & Chemical Mfg. Co.	36
Chambers Bros. Co.	**21**
Chicago Vitreous Enamel Product Co.	**23**
Colling, H. T., Co.	30
Consolidated Feldspar Corp.	**29**
Corundite Refractories, Inc.	**37**
Drakenfeld & Co., B. F., Inc.	**41**
Edgar Brothers Co.	Insert
Edgar Plastic Kaolin Co.	Insert
Erwin Feldspar Co.	**29**
Eureka Flint and Spar Co., Inc.	**21**
Exolon Co.	**19**
Ferro Enamel Supply Co.	**37**
Fisher Governor Co.	**3**
General Electric Co.	28
Golding-Keene Co.	**27**
Golding Sons Co.	**29**
Hammill & Gillespie, Inc.	**23**
Harbison-Walker Refractories Co.	**19**
Harshaw Chemical Co.	**8**
Hommel, O., Co.	**27**
Innis, Speiden & Co., Inc.	**34**
Journal of the Society of Glass Technology	**39**
Jungmann & Co., Inc.	37
Kentucky-Tennessee Clay Co.	**25**
Lake County Clay Co.	Insert
Leeds & Northrup Co.	**1**
McDanel Refractory Porcelain Co.	**30**
McLanahan-Watkins Co.	35
Metal & Thermit Corp.	Outside Back Cover
Mitchell Clay Mfg. Co.	31
Montgomery Porcelain Products Co.	**21**
Mueller Machine Co.	17
National Silica Co.	**15**
Norton Co.	**4**
Old Hickory Clay and Talc Co.	32
Pacific Coast Borax Co.	**19**
Pangborn Corp.	31
Pennsylvania Pulverizing Co.	**17**
Pennsylvania Salt Mfg. Co.	**25**
Philadelphia Drying Machinery Co.	42
Potters Supply Co.	**15**
Proctor & Schwartz, Inc.	Inside Back Cover
Professional Directory	**30**
Roessler and Hasslacher Chemical Co.	Inside Front Cover
Seaboard Feldspar Corp.	39
Southern Feldspar, Inc.	27
Spinks, H. C., Clay Co.	**26**
Standard Flint & Spar Corp.	**27**
Taylor Instrument Co.	32
Titanium Alloy Mfg. Co.	Center of Book 10
Tyler, W. S., Co.	Center of Book 9
United Clay Mines Corp.	**25**
United Feldspar Corp.	38
U. S. Smelting Furnace Co.	**11**
Vitro Mfg. Co.	**23**
Westerfield, G. G.	38
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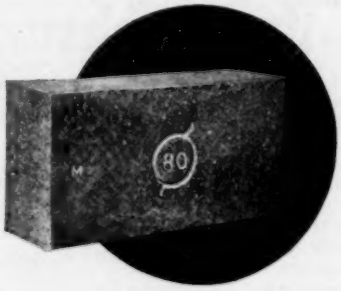

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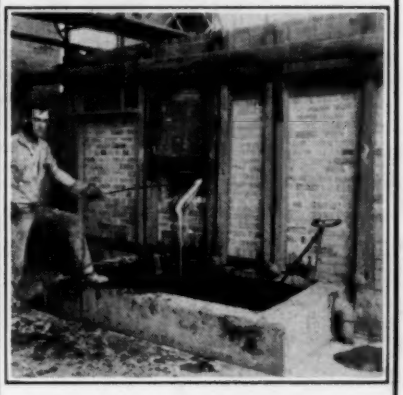

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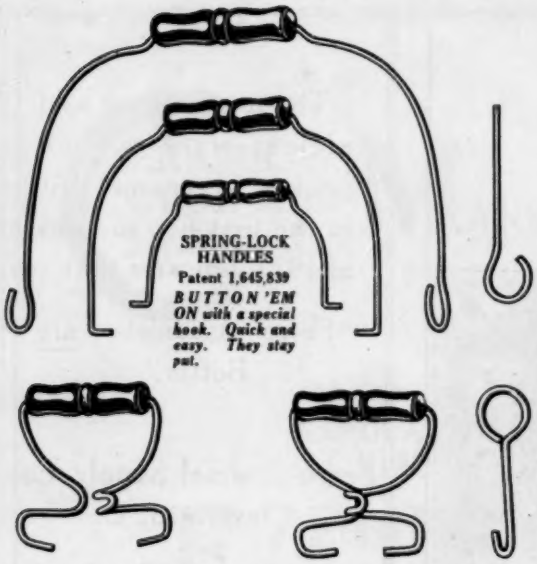

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In spite of the grandiloquent claims made for various substitutes, it still remains ***the only satisfactory opacifier,*** unrivaled in ease of working, freedom of defect-producing qualities, and in beauty imparted to the finished product.

Even if

M and T Tin Oxide

were selling much above its present price, you would actually be ***losing money*** on every pound of substitute you purchased, beside ***accumulating grief*** for yourselves—

And We Can Prove It

We are doing this every day, and will be glad to do it for you.

Metal & Thermit Corporation

Ceramic Department

Homer F. Staley, Mgr., R. R. Danielson, Director of Research

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